The Geography of the Polar and Sub-Polar Regions

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THE GEOGRAPHY OF THE POLAR AND SUB-POLAR REGIONS

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INTRODUCTION

to

THE GEOGRAPHY OF THE POLAR AND SUB-POLAR REGIONS

This thesis has been written in order to acquaint others with the regional geography of the polar and sub-polar regions of the world. A strong possibility that these areas may be opened and developed is evident now. What is there, that man can want? Will it take another war to stimulate our minds and learn about these polar environments? This thesis tells the facts that are of importance to the growth of these spheres, and information to give a better appreciation of them.

These regions are not generally known. The polar areas are the "ice caps" and "tundra". The sub-polar region is the "taiga". The name "ice caps" refers to a region having a constant ice cover; the "tundra", to the treeless plains of polar regions; and the "taiga", to a heavily forested area.

The material is organized under Polar Ice Caps, Polar Tundra, and Sub-Polar Taiga and follows a specific sequence. Each region is discussed in the broadview first. The topography, climate, vegetation, animals, inhabitants, and minerals come next and complete the pattern. Professor Fenneman's words help to state the scope of my purpose.

"The circumference of geography includes notable areas in the fields of astronomy, geology, meteorology, biology, economics, and history, and the geographer should not be ashamed to admit that he must borrow freely from these and other sciences. It is the areal relation, after all, that makes geography and the central core of geography is regional geography."*

The broadview gives general ideas for a better understanding of a particular region before it is divided into its smaller areas and zones. It is my intention, in this division of the thesis, to cover, briefly, each of the three major regions under topography, climate, plant life, animal life, and inhabitants so that there will be a background for additional information found in corresponding headings under the more specific areas.

Each region has a characteristic topography depending upon its latitude, dimension, glaciation, geology, mountains, plateaus, lowlands, soil, and systems of drainage. I have placed the regions of the Northern Hemisphere to lie northward from 48 to 50 degrees N latitude and of the Southern Hemisphere southward from 53 to 55 S latitude. The vastness of the Arctic Ocean corresponds to the white expanse of the Antarctic Continent. The large extent of the northern tundra contrasts with small tundra in the south. The magnitude of the taiga areas in the north contrast with no such definite areas in the south. Greenland and the Antarctic Continent retain extensive ice caps although, in both regions, scientists report a slow recession of the ice. Islands and archipelagoes of the Arctic Ocean are undergoing the process of glaciation. Ice cover is

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* GEOGRAPHICAL REVIEW October 1945.

retreating from these areas today. The remaining major regions have been glaciated to varying degrees. The Laurentian Shield of Canada and the Baltic Shield of Europe compare similarly as heavily glaciated areas of the world. The two ice capped areas have high mountains and many of their nunataks are free of ice. Tundra regions are, for the most part, plains and lowlands which blend into plateaus in some areas. Mountains in the tundra are few but not entirely lacking. The taiga is a lowland region with numerous swamps and lakes. Much of the taiga remains inaccessible because of its inundated condition. Flowing from the taiga regions northward, through the tundra, to the Arctic Ocean are many large, important rivers. Among these are the Yukon and Kuskokwim Rivers of Alaska, the Mackenzie River in northwestern Canada, and the Ob, Lena, and Yenisei Rivers of the Soviet Union.

Climate is of vital importance to the three major regions discussed in the thesis. Factors which influence the climatic conditions in these regions are the polar air masses, temperature, direction and velocity of wind, solar radiation, and precipitation. The polar continental air masses intensify clear weather, low temperatures, winds and the effectiveness of insolation. The polar marine air masses moderate the temperature and bring precipitation.

Koppen's classification of climates according to temperatures has been used as a guide to determine the limits of the regions although minor deviations were felt necessary. In the ice capped areas there is perpetual frost and the average

temperature of all months is below 32 degrees Fahrenheit. Such climates are present only over the permanent ice caps of the North Pole area which includes the islands of the Arctic Ocean, interior Greenland, the Antarctic Continent, and some of the islands nearest its shore. The tundra region has an average warm month temperature below 50 degrees Fahrenheit but above 32 degrees Fahrenheit. The sub-polar taiga has an average warm month temperature above 50 degrees Fahrenheit and a cold month temperature below 26.6 degrees Fahrenheit. The temperature of the tundra and taiga regions determines the depth of the frozen sub-soil and the persistance of a light snow cover for a period of many months.

The north and northeast Arctic winds and the south and southeast Antarctic winds blow with a greater intensity during the winter than during the summer. These winds originate over the ice or snow covered regions and penetrate into the temperate latitudes of the earth.

Solar radiation decreases as the poles are neared. This weakened insolation has little influence upon the temperatures in the ice capped areas. More benefit comes from sun in the tundra and taiga regions because the bared ground absorbs the warmth. Celestial light of winter is as important in the polar regions as the sunlight of summer.

Precipitation in these regions is in the form of snow, rain, fog, and hoar frost. The moisture content of the air is increased as the mass passes over open water. When the air mass approaches land its moisture is precipitated more often as

snow in the polar areas, and snow or rain in the taiga. Toward the interior of a large land mass, the amount of precipitation decreases.

The thesis attempts to show how polar and sub-polar vegetation flourishes in belts which nearly coincide with the climatic and soil belts. I have emphasized the climatic conditions for they do govern and control plant growth. Lower and higher plant life is supported by these regions. In the ocean waters, lower microscopic vegetation survives in unbelievable quantities. Mosses and lichens are luxuriant lower plant growths of the tundra. Algae are known in some areas, also. Other tundra flora includes low flowering bushes and scrubby trees. Extensive virgin forests of conifers are present throughout the taiga. Agricultural experiments are being developed wherever low temperatures are relieved by solar radiation long enough to thaw frozen sub-soil and increase the warmth of the growing season.

Animal life in the polar and sub-polar regions shows no dearth. The lavish flora maintains some of the largest known animals in the world. Fur bearing animals are the most numerous. They provide various native tribes with food, clothing, and shelter. Insect pests are prevalent in the tundra and taiga areas. Migratory birds use the tundra and taiga for nesting because a varied food supply is sufficient.

Early animals could not be disregarded. In this work, I have attempted to regard such prehistoric animal remains as valuable to the scientists and natives.

No geography is complete without some human element whether it is the explorer or the native population. I have proposed to include a summary of explorations in relation to each region discussed. The entire geography of these regions has been contributed in the accounts of such adventurous and courageous persons. The most daring of these persons endeavored to search farther poleward and thus they have revealed natural phenomena which encourages men to learn of polar and sub-polar possibilities and develop areas which may be of future value to commercial nations.

The native tribes inhabit coastal regions, and for the most part, subsist upon large sea mammals. These primitive peoples can maintain themselves in their environment without aid from white people. Today white men encourage these natives to continue their native customs of eating and clothing. White man, in the polar zone, has adopted certain native ideas as the best theory to support health. Throughout the thesis I have introduced the tribes with the area to which they belong. Each tribe has been considered according to its origin, methods of livelihood, religious practices emphasized by marriage, death, and leadership, and customs which pertain to shelters, preparation of food, and attitude toward newcomers.

Each region has minerals of great importance. Throughout the body of the thesis are attempts to evaluate the natural resources as possible future wealth to the nation that claims the territory. Conditions of mining operations have been included to prove that success was the result of careful planning and

skilled engineering in these zones handicapped by unfavorable climate and surface conditions. What is the purpose of interest in these reserves? I hope the thesis will answer that question satisfactorily by stating the location of major deposits, their size, their future usefulness, and the nations which are particularly concerned about ownership and usage.

The material has been selected from the written accounts of explorers and other well known persons. Names of land and water areas, mountains, lakes, rivers, and cities have been spelled according to the "National Geographic" as a first preference and, "Goode's School Atlas" as a second choice.

PART I

POLAR ICE CAPS

Including

THE HIGH ARCTIC

Broadview

Torography

The land area of the ice caps, high arctic, and tundra is approximately 6,724,000 square miles or thirteen per cent of the land surface of the earth. The ocean area is 13,000,000 square miles or nine per cent of the water on the globe. One-fifth of our earth's surface is permanently frozen.

Arctic land areas included in the ice cap and high arctic region are the American Arctic Archipelago, Greenland, Jan Mayen, Bear Island, Spitsbergen, Franz Josef Land, Novaya Zemlya, North Land, New Siberian Islands, and DeLong, Wrangel, and Herald Islands. The Antarctic Continent and some of its off-shore islands are a part of this region. The Arctic Ocean is discussed apart from the land.

Greenland and the Antarctic Continent are the two major ice-capped areas. They are ice deserts. Both are plateaus from which rise numerous mountains to elevations of 6,000 to

15,000 feet. These areas have similar glacier forms but different marginal features.

The American Arctic Archipelago has a diverse surface of lowlands, plateaus, and mountains. Its high eastern mountain section is glaciated. Much of this archipelago lies in the high arctic belt and shows no effects of previous glaciation. The almost complete lack of ice cover, past and present, is a polar riddle.

The other islands and archipelagoes are smaller in area. Their major land forms are plateaus and lowlands existing under varing degrees of glaciation.

Certain sections along the margins of the islands and archipelagoes were once under the ice. Erosion by ice and water have worn the rocky surface. This has left lakes and other areas where patchy vegetation grows. Such a surface is termed "rock desert".

Climate

Two types of polar climate govern this zone. The Antarctic zone type has the 32 degree isotherm for the warmest month and all other months are below freezing. Included in this more uniform temperature belt are the Antarctic Continent and its surrounding islands, Greenland, and ice covered areas of Arctic islands and archipelagoes. This type climate lacks a growing season and is the least well known. The high Arctic belt is the second main belt. The warm month temperature ranges from 32 to 41 degrees Fahrenheit and ice remains the characteristic feature. Glaciers can form at sea level and at an elevation of

a few hundred feet. Snowdrifts form in wind-protected places. In the summer the highlands are usually ice covered and the lowlands ice free. In the Northern Hemisphere the marginal parts of Greenland, Bear Island, Spitsbergen, Franz Josef Land, Novaya Zemlya, the outer coastal rim of North America and the Soviet Union, and the American Arctic Archipelago (except the southern part) fall in this zone. In the Southern Hemisphere are Heard Island, and the northern parts of the South Orkney and South Shetland Islands. Ice seems to have the greatest influence on the ice cap and high arctic climate. Continental ice climate prevails in Antarctica and Greenland. Drift ice climate prevails north of Siberia and North America. The ice type polar climate has a marine influence on its margins and a continental influence toward its interior.

In this polar region temperatures are lowest during calm weather. The air in these high pressure areas is cooled by the snow and ice. Slight wind causes snow to drift. Anticyclones are fair weather areas with some clouds, usually of the cirrus type, and a meager snowfall. Winters are dry, stable, and clear. Anticyclones of summer bring clear, cool weather and strong solar radiation. The polar temperature is the lowest annual and summer temperature for the earth. The low summer temperature is due to the cooling effect of the ice and sea upon the climate. Ice is a good conductor of heat whereas snow is a poor conductor.

"In the interior of the anticyclone air currents are drawn downwards to replace the outflowing air on the

> surface. These down-flowing currents, drawn from the top of the troposphere, carry with them minute ice spicules such as are found in cirrus clouds. By adiabatic heating the ice spicules are turned into water and vaporized, but on the air being cooled again by the cold surface of the ice-dome the moisture is precipitated in fine snow."*

Cold air in a cold front usually undercuts the warm air and causes it to rise. W. H. Hobbs'[1] theory of glacial anticyclones is that the cold katabatic winds descend ice slopes under force of gravity. These winds are confined to and caused by the dome-shaped ice caps of Antarctica and Greenland. These ice caps are poles of wind flow. At the edge of the ice cap the highest velocity is attained which causes adiabatic heating. When the downrush stops a calm supervenes. Wind sometimes blows the snow and causes electricity.

"Through friction of the fine grains of ice against one another the air became saturated with electricity, so that sparks of St. Elmo's fire were to be seen even on our clothing."**

Two theories of cyclonic origin are the polar front theory and the Norwegian wave type theory. The first is that the polar front is the irregular frontal zone formed by the origin of the tropical westerlies and polar easterlies. In the Norwegian wave type the cyclone originates as a wave separating air masses of contrasting temperatures and humidities along a surface of discontinuity.

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* THE POLAR REGIONS R. N. Rudmose Brown p. 44.
** THE GEOGRAPHY OF THE POLAR REGIONS Otto Nordenskjold and Ludwig Mecking p. 18.
1. Ibid.

Precipitation is usually light in this polar area and falls in the form of snow or fine ice crystals that are dry, hard, and sand-like.

"The moisture content of the air is so slight that only minute crystals form in it with a crackling sound, and the slightest sounds are audible at remarkable distances."* The origin of this precipitation is not well understood. Hobbs states that some moisture over ice regions is precipitated as hoar frost.

> "Hobbs proceeds from the fact that in Greenland as well as in Antarctica an anticyclone with high pressure and outflowing winds lies over the high inland ice, where, however, the air is not, as in other anticyclonic regions, dry but relatively moist, finding in the cirrus clouds an adequate source of supply for this moisture. This moisture is then supposed to be precipitated as hoar frost by extreme cooling at the surface of the ice...Several investigators have latterly shown that precipitation of frost is of great importance in certain semi-polar mountain regions, that is in Norway."**

There is a small loss of moisture by evaporation. The snow around both poles disappears by sublimation even with the air temperatures below freezing. Icebergs are numerous. The slight precipitation creates a torturing thirst among people from the temperate zones. Snow is best for quenching thirst. It should be eaten slowly over a long period. In order to eat ice it should first be grained to a powder and then eaten as slowly as snow.

Polar fog is common due to the inflow of warm air (from the lower latitudes) over open water to meet the cold air over

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* Ibid, p. 114.
** Ibid, p. 35.

the ice pack. These fogs are usually lower in height and not as dense as our fogs. Mirage is frequent depending upon the rapid changes in the density of air as the altitude increases.

> "But the inversion of temperature, which is characteristic of weather conditions in polar regions, means that a dense cold layer gives way at certain altitude to a warmer stratum at a lower density, with the result that the rays are bent back toward the earth. This may result in objects below the horizon being projected within the vision of the observer at sea level, or if the change in density is more rapid, the object may be seen in an inverted image, sometimes above the actual object seen by direct vision."*

Cold in the ice cap and high arctic areas is extreme due to the long cold winter and feeble summer heat. The long continued cold makes the climate monotonous. The dry air and the usual high relative humidity helps to make the cold more endurable.

Insolation is wanting or very weak in these areas. It is held in check by glaciers, ice fields, and pack ice. Insolation is needed to raise the polar temperature in summer. Temperatures over the sea are usually higher than over the land because, over the latter there is no influence at work to check the fall of temperature caused by radiation. Therefore lands have more continental conditions. H. V. Sverdrup[2] found that winter air temperatures were always lower close to the ice than one thousand feet higher. This is temperature inversion. On calm days when temperature inversion was in contact with the ice it caused loss of heat by radiation. Air gains in heat by conduction from underlying water thus the surface air never fell

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* THE POLAR REGIONS R. N. Rudmose Brown, p. 55.
2 THE POLAR REGIONS R. N. Rudmose Brown

below -50 degrees Fahrenheit.

The Arctic and Antarctic Circles establish the limit to the zone where the sun is never more than 23 degrees 30 minutes above the horizon. There is a period of twenty-four hours each year when the sun doesn't disappear. The length of the day and night depends on the latitude. The Arctic and Antarctic Circles have no climatic influence. In summer one polar day equals two tropical days. The oblique rays of the sun are not wholly effective. What solar energy there is melts ice or is reflected. Twilight, after the sun has disappeared in autumn, and before it returns in the spring, makes flying less hazardous.

The Aurora Polaris is called the Aurora Borealis in the Northern Hemisphere and the Aurora Australis in the Southern Hemisphere. The southern aurora is paler and less impressive than the northern. Their luminosity is caused by emanations from the sun which move toward the earth at high velocity, become ionized as pressure decreases and finally collide with matter in the atmosphere. After entering the earth's atmosphere they are under the influence of the magnetic field and arrange themselves in spirals. The Aurora Polaris forms in luminous bands or rays like waving drapery or dart like the rays of a distant searchlight. They are always in movement and change rapidly. The auroral light shows the prevalence of nitrogen for it is usually white, tinged with yellow and red, and sometimes with the rarer greens and violets. The amount of light is usually less than the moon's light when it is at its quarter.

In the Northern Hemisphere, auroral frequency is located in Ellesmere Island; in the Southern Hemisphere, there is some uncertainty but the displays seem to be near the magnetic pole in Wilkes and Victoria Lands. In the field of terrestrial magnetism and electricity in polar regions the study of magnetic distrubances or storms, the polaris, and electrical distrubances offers fascinating study for a researcher.

There is no pathogenic bacteria in polar regions therefore humans are not subject to colds and other respiratory diseases are rare. Frostbite, though, is quite common. Frostbite should be treated with heat and after thawing the affected part should be kept at a low temperature. The thermodynamic law of frozen flesh by applying cold snow or ice to the frostbite is poor because it retards the thawing. Flesh and snow temperatures will become equalized. If the snow is below a freezing temperature its application could and would cause a deeper frostbite.

The Arctic differs from the Antarctic in climate because of its more seasonal variations due to its nearness to large land masses and land locked sea. The difference in the Arctic and the Antarctic climate lies in the length of the freezing period. Antarctica has an earlier winter following a very cold autumn. The chief difference is in the Antarctic summer for the average temperature remains below freezing in the warmest month. Winds are much stronger in the south than in the north. The ice capped region of the Southern Hemisphere is a large isolated land mass with a plateau elevation well over 6,000

feet completely covered with ice. The inland ice of the south extends nearly everywhere beyond the coast into the sea. The ice foot lies along the narrow seaboard belts. In the Northern Hemisphere this region is mostly water with pack ice. The north has many glaciers of the Spitsbergen type on the high interior.

Life

Algae are found in some of the ice capped regions. In the high arctic belt there are low growing shrubs and grasses in favorable places. Phanerogram vegetation extends to the poleward limit of the high arctic belt in the Arctic but the Antarctic has no such plant life. Higher plants are found in knolls or mats separated by bare and sterile areas. The colder the summer the sparser the vegetation. Beautiful flowering plants are typical in this area. Arctic scurvy grass and sub-Antarctic Kerguelen cabbage have antiscorbutic properties which are helpful for the prevention of scurvy among polar explorers. The sea is full of rich flora.

Sea mammals are more abundant than land animals. The seal, walrus, and whale are the most important. There are six kinds of seals and many whales. Animal life in the Arctic and Antarctic is of definite contrast. The former is varied and numerous; the latter limited and scarce. The Arctic Ocean and land abound with plant and animal life for the support of man, whereas the Antarctic Continent is, supposedly, a barren desert. For this reason Arctic exploration is several centuries old and the Antarctic region has been left unexplored until recently.

Clothing

Clothing is primarily for retaining bodily warmth in the ice cap and high arctic region. The feet are best protected for warmth and dryness by blanket cloth slippers over woolen socks covered by a large boot or moccasin. The surface of the body itself is first covered by a material that is a bad conductor of heat. Many layers inside are covered by a two piece wind-proof outer garment necessary to retain a stable layer of air around the body. Air is the simplest and most convenient non-conductor of heat. The Eskimo likes caribou skin best because it is strong, lightweight, and warm with an air filled cavity in every hair.

Dry clothing is the whole secret of body warmth. Clothing must be the kind that will prevent hoar frost from forming on the inside. It is better to have many layers of thinner clothing which allows air space between. Condensation of the body moisture can't be prevented but can be dealt with sensibly. Sweating must be kept at a minimum for it dampens the clothes and then freezes. Loss of vitamin C due to sweating hastens the coming of scurvy.

Flying clothes are best made of deerskin because it is soft and warm.

Travel

Early travel in polar regions was by sledges using men, reindeer, ponies, and dogs. In the Franklin search[3] manpower

3 THE POLAR REGIONS, R. N. Rudmose Brown.

was used to pull sledges and carry equipment. Nordenskjold,[4] in 1872, tried to use reindeer to reach the North Pole from Spitsbergen, but they ran away. Recently reindeer have been used as pack animals on the tundra. Sledges drawn by dog teams are preferred to men haulers or to reindeer. Dogs are preferred on ice and are the most common way of travel today. Temperatures of -50 to -60 degrees Fahrenheit cause snow to have sharp hard angles which act upon steel runners of the sledges as would beach sand. Therefore, ice shoeing is best. Winter travel is safest in the ice cap and high arctic region.

Newer methods of polar travel have been introduced for exploratory purposes. The Russians have introduced the ice-breaker. It has been successful. The two latest developments are the snow motor and the airplane. The intense cold makes it difficult to start motors. Both have been used successfully with the general feeling that, with the airplane, much more accurate exploration can be accomplished.

"I believe that for expedition work in the Arctic and Antarctic an expedition that combined dogs teams and aircraft would be most effective."*

Men often go hungry in polar regions but they have all the necessary vitamins. Food is purposely dehydrated and its roughage removed to lessen the load on sledging journeys.

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4. THE GEOGRAPHY OF THE POLAR REGIONS Otto Nordenskjold and Ludwig Mecking.

* THE BYRD ANTARCTIC EXPEDITION 1928-1930 American Geographical Society W.L.G. Joerg, p. 52.

The remaining problem to be solved is finding the best means of transportation to bring these cold areas into contact with the temperate regions.

Arctic

Exploration

Pyhthias of Massilia[5] is regarded as the first Arctic explorer. This great discoverer sailed to Thule, which is Iceland, and from there to eastern Greenland. The Norwegian noble Ottar[6], is recognized as the discoverer of Barents Sea and White Sea between 870 A.D. to 890 A.D. Fridtjof Nansen[7] made the first thorough investigation of the Arctic Ocean in 1893-1896 when he crossed the Arctic Ocean in the "Fram" by drifting with the ice.

By the end of the sixteenth century men began to think of a possible northwest and northeast passage. England assumed leadership of the two undertakings. Martin Frobisher[8] began exploring for the northwest passage in 1576. He made three voyages to Baffin Land between 1576-1578. In 1585-1587, John Davis[9] reached 72 degrees 12 minutes N latitude in Davis Strait. His efforts led to the establishment of a British whale fishery. William Baffin,[10] in 1616, reached Smith Sound and 77 degrees 45 minutes N latitude, and (north and south of Devon Island) discovered Lancaster and James Sounds, and the entrance to the northwest passage although he didn't know it. W. E. Parry,[11] in 1818, navigated Lancaster Sound, reached Banks Strait, discovered islands in the heart of the archipelago, and almost discovered the northwest passage. He had

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5-11 THE POLAR REGIONS, R. N. Rudmose Brown.

to retreat because of the ice. John Ross and his nephew J. C. Ross[12] came very near discovering the northwest passage in the 1820's. They discovered Franklin Passage, Victoria Strait, and King William Land. Thomas Simpson[13] worked ambitiously to find the passage. McClure,[14] in the 1830's, found the northwest passage while searching for the lost Franklin expedition. Thus the purpose was fulfilled. McClure made the journey through the northwest passage, partly by ship and partly on foot.

The greater part of the American Arctic Archipelago was explored in 1845 while searching for the lost Franklin Party. According to Stefansson in his "Unsolved Mysteries of the Arctic" the lost Franklin Expedition neglected to profit by the mistakes of Franklin himself, and other explorers and allowed their bodies to become weakened by improper diet. Inglefield,[15] in 1852, stated that Smith Sound in the northern part of Baffin Bay was not a bay but a wide strait. In 1875, Sir G. S. Nares[16] discovered Grinnell Land (Grant Land). Grinnell,[17] an American, discovered Grinnell Land and the central section of Ellesmere Island. O. Sverdrup and G. Isachen[18] determined the limits of the American Arctic Archipelago in 1899 to 1901. Between 1898-1902, O. Sverdrup made important discoveries on Ellesmere Island as did Stefansson again in 1913-1918 when he explored the southern extent of the American Arctic Archipelago.

Roald Amundsen,[19] in 1903-1904, sailed through the North-

12-18 THE POLAR REGIONS, R. N. Rudmose Brown.
19. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

west Passage and fixed the north magnetic pole at 70 degrees 30 minutes N latitude and 95 degrees 30 minutes W longitude.

Explorations were being carried out to locate the northeast passage at approximately the same time. In 1584, one vessel of the Muscovy Company of Merchant Adventurers was wrecked at the mouth of the Ob River. Henry Hudson,[20] in 1607-1610 or 1611, searched for the northeast passage by sailing north to the eightieth parallel near Spitsbergen and went as far as the mouth of the Ob River. S. Deshnev,[21] a Russian, passed through Bering Strait in 1648. As members of the Muscovy Company of Merchant Adventurers, A. Pet and C. Jackson[22] sailed into the Kara Sea in 1850. The first northeast passage was made by A. E. Nordenskjold[23] in 1878-1879 who traveled by way of the Kara Sea to Japan in the "Vega". He had to winter in the ice on the trip. Later, in 1914-1915, B. A. Vilkitski[24] accomplished the northeast passage in icebreakers. Roald Amundsen,[25] in the three years between 1918-1920, succeeded in making the passage to the Pacific Ocean. In 1929 the use of an icebreaker fleet was begun and, in 1932, the first voyage was made from Achkangelsk to Vladivostok in a single season. This brought about the possibility of mastering the northern sea route.

"During the navigation period of 1940, more than one

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20. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.
21. THE POLAR REGIONS, R. N. Rudmose Brown.
22. & 23. Ibid, ff. 20.
24. & 25. Ibid, ff. 21.

hundred ships, or approximately one-sixth of the Soviet mercantile marine, made use of the Northern Sea Route".*

Greely,[26] an American, in 1881, set forth the idea of strictly scientific observations in the polar regions. Eleven nations cooperated in a survey called The International Polar Year.

Many attempts were made to reach the North Pole. S. A. Andree[27] made the first attempt to explore the Arctic by air. He tried to reach the North Pole by using a balloon but his trip ended in disaster. Peary,[28] in 1891, began a series of expeditions that lasted for a quarter century. He traveled via Smith Sound. Peary was successful in reaching the North Pole on April 6, 1909 by a direct route from the northern part of Ellesmere Island. In 1926, Amundsen, Ellsworth, and Nobile[29] traveled from Spitsbergen in an airship and crossed the North Pole to Point Barrow and Telfer, Alaska. In the same year Richard E. Byrd[30] flew from Spitsbergen to the North Pole and back. Wilkins,[31] in 1927, left Point Barrow, Alaska and flew northwest 528 miles by airplane.

There has been no proof as to whom discovered Greenland. Greenland, according to Stefansson, was discovered by the Greek, Pytheas. It is possible that Pytheas of Massilia, the first Arctic explorer, discovered Thule, or Iceland, and from

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26. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.
27.-30. THE POLAR REGIONS, R. N. Rudmose Brown.
31. Ibid, ff. 26.

here saw the coast of Greenland. Also, Norsemen reached Iceland and from this island Greenland's presence could be seen on a clear day from Iceland's northwest position. America was discovered from Greenland by Eric the Red. Greenland was discovered by the Eskimos from Ellesmere Island during their hunting. Knowledge of Greenland is full and thorough.

Hans Edege[32] settled in Greenland in 1721 to search for the descendants of the Norsemen and to convert the Eskimos. The first Danish colony at Godthaab was founded by him. The runic stone found at Kingiktorsuak at 72 degrees N latitude gives definite evidence of the Norse in the north. Eider duck nests are typical shelters built by the Norsemen for eider ducks. The Norse tried to encourage the ducks to settle there, protected the fowl and its eggs, and collected the down. The Eskimos did not do this for they kill the ducks and eat their eggs.

The ninteenth century explorations covered territory in the north and east not previously known. Knud Rasmussen and Lauge Koch[33] approached this area by Smith Sound. Rasmussen[34] indicates that the Norse in Greenland went farther north than where the rune stone was found. Occasionally they went to Smith Sound at 77 degrees N latitude. Koch and Wegener[35] crossed Greenland using ponies. In 1869-1870 the second of two German expeditions under Petermann[36] discovered Emperor Francis

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32. & 33. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.
34. GREENLAND, V. Stafansson.
35. Ibid, ff. 33.

Josef Fiord. Nathorst[37] continued the explorations. In 1886, R. E. Peary[38] carried on Arctic explorations in Greenland. The northern extremity of this island was reached in 1900. Peary also made two crossings of the Greenland ice cap. Peary organized the Etah Eskimos for a march to the pole. He had 133 dogs, 23 men, and 19 sledges. This type organization worked well. Fridtjof Nansen[39] explored the interior in 1888. He crossed Greenland on snowshoes. The northeast corner was discovered and explored by Mylius and Ericksen[40] in 1906-1908.

Spitsbergen, discovered by Norsemen in the twelfth century, was re-discovered by Barents[41] in 1596. Today this archipelago serves as a base for advance to the pole.

In 1872-1874, Franz Josef Land was discovered by an Austrian expedition under J. Payer and C. Weyprecht[42] when they attempted to locate the northeast passage. Explorations were made by B. Leigh Smith[43] in 1880 and F. G. Jackson[44] in 1894-1897.

Sir Hugh Willoughby and R. Chancellor,[45] members of the Muscovy Company of Merchant Adventurers, discovered Novaya Zemlya and the White Sea in 1553. Russia led in the exploration of these islands for the wealth of fish in the waters surrounding this area attracted many fishermen from Russia and Norway. Loshkin,[46] a Russian, circumnavigated Novaya Zemlya in the eighteenth century.

37.-41. THE POLAR REGIONS, R. N. Rudmose Brown.
42.-46. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

B. A. Vilkitski[47] discovered North Land in 1913.

Although the New Siberian Islands were seen in the middle of the seventeenth century, Bunge and von Toll[48] made their location definite in the 1880's.

Bering Strait (in the rear of the Great Arctic Drift), Franz Josef Land, Spitsbergen Archipelago, and Smith Sound (with its heavy but firm ice) are the preferred regions for Arctic exploration.

Arctic Ocean

The Arctic Ocean is sometimes referred to as the Polar Mediterranean because of its nature and size. The ocean is divided by two series of basins. Beginning north of the Faeroe-Island ridge there is the Norwegian Basin between Jan Mayen and Bear Island; the Spitsbergen Basin, between Spitsbergen and northeast Greenland; and the Fram Basin, between the New Siberian Islands and Spitsbergen. More information is needed in regard to the deep sea basin which is believed to exist between Spitsbergen and Franz Josef Land. Another basin, which may lie in the Beaufort Sea, arouses considerable discussion.

The Arctic Ocean is frozen much of the year causing it to be very cold and ice-locked. The limit of the ice zone depends on the temperature, fog, and wind. In the Arctic, the snow

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47. & 48. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

covered land is hardly distinguishable from the ice covered sea. The bottom material of the Arctic Ocean is very fine. It is supposed that the tides in the Arctic Ocean have little change but further study is necessary to determine the tides accurately.

A Polar Continental Shelf is known to extend around the central sea and is believed to be wider on the European side. However, the continental shelf isn't accurately mapped nor do we know whether this continental shelf marks the real boundaries of the continents.

F. Nansen, adrift in "The Fram" from the New Siberian Islands, thought he could drift to the North Pole in the currents of the Arctic Ocean. This first penetration of the Arctic Ocean revealed information about the ocean currents. It is expected, in the northern hemisphere, due to the earth's rotation, that the Arctic currents would be deflected to the East. Nearly the opposite is true. It would be interesting to find out whether the ocean bottom has anything to do with the direction of the ocean currents and ice drift.

Drift ice obstructs ships. Ice at no time disappears from the Arctic Ocean. Some melts, and large amounts are carried away in the East Greenland Current. Drift ice is also carried by the Gulf Stream which receives icebergs from the Labrador Current.

"From beyond the range of vision the larger ice masses announce their presence by the iceblink...a bright shining

strip in the sky over the ice."*

Driftwood of Siberian and American origin is also carried along by the currents of the Arctic Ocean. Driftwood of American origin comes from the Mackenzie River and its tributaries. This spreads along the Alaskan coast to the westward. Driftwood of Siberian origin is carried in the Arctic Drift to Franz Josef Land, Spitsbergen, and Greenland.

Ice gets dirty in the Arctic Ocean. Snow, no matter where, always contains fine dust from the air. Sea organisms sometimes color the ice quite brown. Old ice is always dirtier and darker than the new. Heavy floes when packed together, crack badly. There is noise and movement of pack ice.

> "The hummocks in the Kara Sea and in the Arctic Ocean as a whole, are formed by ice pressure. They are floes that are squeezed edge to edge by severe pressure of wind and current, when they break up, are raised on end and pushed one above another, till they are piled up into hummocks twenty or thirty feet high above the water."**

A study of Arctic Ocean ice could be made to determine ways to tell pack ice from drift ice by age, cracks, and hummocks. The Arctic Ocean is filled with billions of ice cakes of all sizes. Sea ice is sluggish. In winter the ice cakes are huge and in summer they are small. Ice loses its saltiness if it remains a cake floating in the seas for a few years. There is ample opportunity for the researcher who wishes to study the Arctic Ocean waters.

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* THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

** THROUGH SIBERIA THE LAND OF THE FUTURE, Fridtjof Nansen translated by Arthur G. Chater, p. 44.

The North Pole lies in deep water but the extension of this deep sea needs to be sounded.

The Pole of Inaccessibility was fixed by Stefansson[49] with its center at 84 degrees N latitude and 160 degrees W longitude.

The Beaufort Sea of northwestern Canada has many straits but no permanent current. Baffin Bay and Davis Strait are caused by deep faults which left a trough.

Today aviation is of great importance in developing the Far North. The conquest of the Arctic has just begun and, as exploration progresses the problem of political rights to the polar north will require solution. Greenland is recognized as Danish but other islands and archipelagoes have been given no recognition.

Along the Arctic fringe north of Europe and the Soviet Union there are six seas. The Norwegian Sea, between Greenland and Spitsbergen, and the Barents Sea are influenced by the Gulf Stream. The Gulf Stream merges with the East Greenland Current and the Siberian Shelf Sea that gradually disappears in polar waters and ice. The Barents Sea gives hardly any trouble to the navigator. Ice is the obstacle in the Kara Sea. Ice conditions are liable to great variations from one year to another. Navigation depends upon the quantity of ice, its spread and distribution, winds, current, and depth of sea water. In summer the waters are open for three months. Fog

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49. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

and ice make August cold and dismal. Because of the ice condition patrol service is required. Wireless stations and airplanes have been on patrol since 1913. The westward current of the Kara Sea follows the coast, tears off the ice, and drives it off-shore. Unity Island, later named Isachenko, is a small island discovered in the northern part of the Kara Sea in 1932.[50]

Navigation around the Taimyr Peninsula has the most favorable ice conditions when the winds blow from the northeast or south. The most unfavorable conditions exist when the winds are from the southwest or north. Other winds bring a neutral condition. The Laptev Sea is east of the Taimyr Peninsula.

The shallow East Siberian Sea lies on the continental shelf. This sea terminates at Wrangel Island where the worst ice condition is found. The East Siberian Sea was used as a trade route by the Russians who traded with the people at the mouths of the Ob and Yenisei Rivers in the eleventh, twelfth, and thirteenth centuries. Makarov[51] calls it "the facade of Russia's mansion." Today Russian icebreakers are used here.

The chief characteristic of the Chukchee Sea is that it is more open toward the polar basin than any other northern sea. The main current is north and east and flows toward Cape Hope, Alaska. In winter the drift is principally along the coast. The ice in the Chukchee Sea is of many years' formation.

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50. THE VOYAGE OF THE CHELYUSKIN, translated by Alec Brown.
51. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

Chukchee Sea leads into Bering Strait.

The Northern Sea Route is fast becoming the Soviet's Panama Canal. The Northern Sea Route Administration operates regular services to various rivers by using icebreakers and airplanes. During many years, boats can't reach the mouths of the Ob or Yenisei Rivers because of the floating ice. The Northern Sea Route handles not more than twenty ships a year and only one round trip is made. There is need of cargo boats of the icebreaker type. War secrecy has prohibited information about the route.

The Arctic is the best all year round air base. Hydroplanes utilize it in summer. Their pontoons are replaced by skiis in winter. In winter the planes land on ice floes which might be twenty miles in length. Some ice floes reach twelve to twenty feet in thickness. By sudden blast, solid floe ice can be changed into ice porridge. Fog over the northeast passage is dense and consequently visibility is poor.

During the voyage of the Cheluskin it was discovered that the ice-field over the ocean vibrated in ice waves. It was noticed first in the surface of a young pool of ice. The bubbles in the instrument being used to secure magnetic calculations indicated wave motion. The principal cause is the wind for the largest wave was in the direction of the wind. With the same force and direction of wind and drift the waves lengthen. The packing of ice floes accompanies the change. The most important increase in waves is during a calm which precedes the approach of masses of air. The wave occurences

are used to tell how near a ship is to clear water or floating ice. They can also be used to tell the distance of ice from the shore.

The Soviets have developed a weather and ice reporting system to aid shipping and flying along the Northern Sea Route. During Russia's first Five Year Plan 1929-1933, she had twenty-two weather outposts. The purpose of these stations was to make regular observations, send out daily weather reports to Moscow, and to make long period weather forecasts for the Soviet Union. There are a variety of observations made on sea and land. They try to locate minerals, tell the disposition of furred animals, investigate solar radiation, and study atmospheric electricity. These stations forecast weather and the situation of the ice. The use of airplanes for these observations is becoming more popular.

> "The success of the Northeast Passage has depended not so much on the development of the powerful icebreakers or specially constructed ships as on radio reports of ice character and ice movement. The reports come from observatories on every strategic promontory, whether on mainland or islands, and from airplanes that swarm everywhere along the 3,000 miles of the Northeast Passage during the three months navigation season. Ice forcasting, which combines meteorological with ice studies, enables the commander of a fleet of freighters or warships to plot on a map two or more times a day the location of ice on the entire passage, with its character and speed of movement. The forecasters can even tell him approximately where the ice that is here today will be tomorrow or the day after that. A fleet may have to go several hundred miles out of its way; but in this way it may avoid even seeing an ice field, which otherwise would have blocked the passage to the most powerful icebreakers."*

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* ARCTIC SUPPLY LINE, Fortune Magazine, July 1942, Stefansson.

Climate

In the Arctic there are two high and two low pressure areas for the origin of polar climate. The high pressure areas originate over the polar ice cap and the snow covered plains of Canada and Eurasia. The poles of cold lie on the high pressure saddle in Siberia, the American Arctic Archipelago, and Greenland. The two low pressure areas lie near Iceland and the Aleutian Islands. The depressions hardly ever reach the North Pole and rarely do they extend beyond 80 degrees N latitude.

The high latitude air masses form over homogenous surface conditions and the air movement is light. The Arctic air masses are cooled by snow and ice that maked them typical anticyclones. G. C. Simpson[52] believes that there are various layers of air over the ice. The lower layers of air are stagnant and are the coldest because of their density. The upper layers of air slide over the lower layers. When the upper layers move so rapidly that they disturb the lower layers and cause them to ascend and fall as snow, blizzards are the result. Phenomena of this kind has been noted in North East Land, Ellesmere Island, and the northern island of Novaya Zemlya.

The anticyclones of the Arctic Basin source region enter upon the continents and make an arctic continental source which brings cold waves and bitter winter weather to Canada, the United States, Europe, and Asia. Anticyclones are fair weather areas with some clouds and a meager snowfall. Cold waves in

52. THE POLAR REGIONS, R. N. Rudmose Brown.

winter bring dry, clear, cool weather which is ideal for terrestrial radiation during the long winter nights. A slight wind causes the snow to drift. In summer the anticyclone source region lies over areas of melting snow and ice, or icy waters in the northernmost part of Eurasia and North America and brings clear, cool weather and allows a strong solar radiation to be effective.

The two low pressure areas for the Arctic have their sources near Iceland and the Aleutian Islands. The region southeast of Greenland is a breeder of cyclones because of a warm ocean water and the intense cold of the Greenland ice cap. It forms two fronts, a weak point or a bulge occurs and under the forces of gradient, earth rotation, and friction it develops into cyclonic circulation. The Polar Atlantic front has a temperature contrast between cold air of Arctic ice fields and the warm air of the North Atlantic Drift.

Polar maritime climate includes the Arctic and Polar Atlantic climates. The air masses are modified over the Atlantic and become mild, humid, and unstable. If they originate over the Arctic Ocean east of Greenland and north of Iceland they differ in character. The short path makes a cold stable air mass containing the coldest maritime air on earth. If it follows a longer path it becomes more mild, humid, and unstable.

Frontal zones of the Northern Hemisphere are numerous and have low, middle, and high latitude characteristics. There is little relation between latitude and temperature for seas,

mountains, and wind areas. Storm directions influence the climate. The front and eastern half of a cyclone has the greater amount of snow.

Precipitation in the Arctic is meager and falls in the form of snow or fine ice crystals which are dry, hard, and sandlike.

In the Arctic the mean temperature of the warmest month is practically always below freezing. The North Atlantic polar islands of Spitsbergen, King Karl Land, Franz Josef Land, Jan Mayen, Bear Island, and Novaya Zemlya have a temperature higher than 41 degrees Fahrenheit on their south and west sides. The mean annual temperature for the North Pole is -8.9 degrees Fahrenheit. In Arctic regions temperatures of -50 and -60 degrees Fahrenheit are occasionally recorded but are rare. Temperatures are lowest during calm weather.

The open sea, in the Arctic Basin, makes easy access to the area for the study of the climate. When the sea is filled with drifting ice in winter, it gives warmth to the nearby lands. Where ice is unbroken the temperature lowers. Southerly breezes cause channels and cracks in the ice field. They smoke.

Arctic fogs, with a thickness of twenty to thirty feet, are lower than the usual fogs. They have a tendency to roll. Some fogs are not too dense or are more or less scattered offering a less hazardous condition for the aviator. Summer comes on quickly - sometimes within eight days. Fog, made by the water and ice, causes a great deception of distance.

Stefansson, in his "Unsolved Mysteries of the Arctic", tries to reveal the plight of some missing Soviet flyers who

attempted a non-stop flight from Moscow to Fairbanks over the Arctic region. He mentions that August is the worst month for flying because clouds are in the sky at this season. Arctic flying is most dangerous when temperatures are just below the freezing point of fresh water. Temperatures between 37 and 22 degrees Fahrenheit are hazardous to aviation because a frosting occurs on wings and propellers. Fogs are common from June to August decreasing each month through November. Usually they are of an icing temperature. Also, during these months, ice breaks up. Rains have been reported by Papanin[53] from the vicinity of the North Pole. Landing in such conditions is perilous. Stefansson believes that it was in landing that the Soviet flyers met their fate.

Light and darkness beyond 66½ degrees N latitude consists of six months of darkness and six months of sunlight. Sunburn in the Arctic can be severe. The North Pole area has loss of heat by continuous terrestrial radiation for their is no direct incoming solar radiation for six months. The moon is of great assistance during Arctic travel in winter.

Arctic colors and moods are expressed by the Aurora Borealis and the midnight sun. Polar peace can be had in the colors of sunset which last the night long, in the grandeur of the fiords, in the floating icebergs, and in the peaks which barely show from under their heavy snowfields. A driftwood fire warms and brightens the cheerless days of darkness. As day

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53. UNSOLVED MYSTERIES OF THE ARCTIC, V. Stefansson.

approaches the diver's call is heard, flying geese return, musk oxen are seen browsing, and the Arctic fox trots along the shoreline searching for his meal.

Weather forecasting is important and can be carried out with the cooperation of other Arctic nations. If more weather stations could be set up and maintained in the various polar areas of the Arctic there could be weather contrasts between the North Pole and the Equator, and contrasts between land and water because both are being acted upon by everchanging intensity of solar radiation. By such procedures the cause for the condensation of water vapor might be determined. American and European people are anxious to know just how the Arctic regions influence the temperate climate. Permanent polar stations have been established in Greenland, Jan Mayen, and Spitsbergen.

The prevailing winds in the northern hemisphere are north or northwest.

> "The effect of these prevailing northerly winds in bringing down ice from the Arctic basin, and filling the straits of the American northeastern Archipelago in summer, is unquestionable, and, is probably the main cause of the abnormal depression of temperature in that quarter".*

Arctic Basin Vegetation

The Arctic Seas are rich in small organic plant life. The coastal area of East Greenland has 124 species of marine algae and is richer in diatoms than West Greenland. In the higher latitudes of the Arctic Ocean plant life is poorer. Not too much is known about the reason for this. It may be that

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* THE POLAR REGIONS, Sir John Richardson.

sunlight is absorbed by the ice and very little penetrates. Yet, life is between the ice floes in the short summers and as soon as the ice leaves, there is an accumulation of rich plant and animal plankton. The smaller forms of polar water vegetation fully utilize the energy from the sun's rays. Water organisms obtain enough light for photosynthesis at about 50 to 60 feet below the surface. In Stefansson's "Unsolved Mysteries of the Arctic", he states that Andree and his companions noticed the sea was full of algae which could be obtained easily and was used in making soup. This would be a good subject for further study.

Arctic Basin Animals

The Arctic Seas are abundant in organic animal life. The characteristic polar forms are the crustacceans and sea mammals. Sea mammals depend on crustaceans and plankton, which are luxuriant in polar water for food. Walrus feed on fish. Natives of the Arctic depend more upon the sea than on the land. Sea life increases as one goes farther north. The large mammals are the whale, walrus, seal, and polar bear. Whales are more valuable to civilized man than to Arctic natives. Whales are fewer than originally but they are still found in the American Arctic and Kara Sea. The whale migrates south in winter. Whale meat, if properly cooked, is like tender beef steak.

There are two varieties of walruses--the clam eater, and the larger variety that feeds on seals, fish, and clams. Both are difficult to hunt, but they are valuable for their ivory.

The walrus is the largest animal of this kind and is used for blubber, meat, and fur. Walruses go south in winter and now they are only found north of Okkak.

Seal skin is the best source of income. Some varieties of seals are decreasing. Seals sun themselves on the ice and have their blowholes. They are used for blubber, meat, fur, and skins.

The polar bear, staying mainly on the ice pack, ventures the closest to land. The flesh of the polar bear is edible except for the liver which is thought to be somewhat poisonous.

Most of the Arctic Basin animals are restricted to the sea, ice fields, and the ice-free coasts. Life seen by Peary at 86 degrees and 88 degrees N latitudes were the polar and Arctic fox. Its flesh is unpleasant for human consumption and does not give the proper fat content necessary in the diet of polar peoples.

Nansen[54] saw the fulmar at 85 degrees N latitude and the ivory gull was seen still farther north. The ptarmigan has a thick cover of white feathers which protect him from the cold.

Animals are affected by the cold. In a dozen warm days an insect can walk, mate, and lay eggs. They appear in myriads. Some Arctic spiders and flies can be active at several degrees below freezing. There is quite a comparison between warm blooded animals. The large polar bear has only a small area through which heat is lost. The lemming, with its small body,

54. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

has a larger surface for loss of heat. Man, in the arctic temperatures, must maintain high uniform body heat. Man's nervous system is very delicate and sometimes the cold overcomes him. The cold causes the polar bear and the lemming to fall into a winter sleep. Pregnant female polar bears go into semi-hibernation with no lowering of the body temperature. Lemmings hibernate in burroughs under the ground for many months. Hibernation retards the body processes. Respiration and pulse are slow. Upon awakening from hibernation the pulse and respiration are faster, there is violent shivering, and the transition is complete within an hour. Man, in the arctic region, has a tendency toward partial hibernation.

Men who live in the Arctic must consume fresh meat to prevent scurvy. Stefansson points out, in his "Unsolved Mysteries of the Arctic", the knowledge of the value of fat along with lean meat. The fat takes the place of carbohydrates in a temperate diet. Arctic people should eat plenty of fresh bear, seal, and bird flesh, fat and lean, to maintain his health.

Arctic

Bering Sea

The Bering Sea has a southern limit at the Aleutian Islands and the Chukchi and Seward Peninsulas as the northern limit. Along the Bering Sea the American coasts are flatter and waters are shallower than those of the Asiatic side. The Bering Sea has two basins; a southwestern deep basin of 13,200 feet and a

northwestern shelf with a depth of 330 feet. The Bering Sea is cold and partly frozen. In winter much pack ice is present in the sea because of the currents and winds. The Pribilof Islands are free from ice the first of May and the Bering Strait is free after the middle of June. Summers in the Bering Sea area are cool. The animals of the Bering Sea and islands are sea birds and seals. Native inhabitants on the interior islands are Eskimos. Americans have hunted seal in the sea.

Tribes around the Bering Sea on the Asiatic coast are, first, the Chukchis of the Chukchi Peninsula and second, the Koryaks to the south of the Chukchi Peninsula.

Commander Islands, east of Kamchatka, are populated by about 600 Aleuts intermixed with Russians, Eskimos, and Asiatic tribes. The islands have dwarf timber, stunted bushes, meadows, and luxuriant grass. The sea otter has practically disappeared from these islands and the sea cow has been extinct for 150 years.

The Aleutian Islands tend to represent the sub-Arctic meadows.

Pribilof Islands have a population of about 480. These islands have about 200 flowering plants and lie in the belt of the sub-Arctic meadows. The seal of the Pribilof Islands are now protected by the United States Government to prevent improper exploitation.

Nunivak Island, off the Alaskan coast was provided with 34 musk oxen in 1930.[55] These animals were brought from Greenland

55. ALASKA JOURNAL, Fall edition, 1947.

via Norway and then to the island after the United States Government had approved of the proceedings.

St. Lawerence Island, half way between the two peninsulas, has a July mean temperature of 44 degrees Fahrenheit. It is unforested because of the temperature and winds. Dwarf timber, stunted bushes, meadows, and luxuriant grass classify it in the tundra belt.

American Arctic Archipelago

Topography

The American Arctic Archipelago, with the exception of Baffin Island, is uplifting. Bays and straits show a drowned condition. The coasts are deeply indented, and the land, though low, rises steeply. Volcanic sheets are present on some of the islands. Sedimentary tableland is also present. The channel for the Northwest Passage is plotted through this archipelago. Recent uplifts in terrace formations occur on Baffin Island to an elevation of 490 feet and on Ellesmere Island to an altitude of 660 feet.

Evidences of intensive glaciation are absent from the American Arctic Archipelago. In the north, especially within the archipelago, about 625,000 square miles are bare of continuous ice. The limestone plateaus have thin ice covers. The limited distribution of ice is found in ice fields and glaciers in the eastern mountainous region.

Banks Island has a coast with small bays and drowned river mouths. Its formation is that of a plateau with lakes.

Victoria Island is a continuation of Banks Island. Nothing is known of its interior. The southeastern part has ice covered bays, snow covered low promontories and islands, and skerries which make it difficult to map the coastline.

The Boothia group consists of Boothia Peninsula, and King William, Prince of Wales, and Somerset Islands. The wide, bare, and barren areas have little glaciation. The plains of King William Island are dotted with many lakes. Gjoa Harbor is situated on King William Island.

Baffin Island has a continuation of the Labrador Mountains which end in a long peninsula extending into Davis Strait. The southern part of the island has a high coast deeply indented with fiords. Even though mountains are secondary features in polar areas the mountains of eastern Baffin Island rise abruptly 1000 feet above the sea. South of Cumberland Sound the elevation is two thousand to three thousand feet and increases, to the northward, to 5000 feet. Pangnirtung, situated on the northern side of Cumberland Sound, is handicapped by a sill of solid rock which is exposed at low tide and the water is shallow at high tide. The interior of Baffin Island is mostly unknown. From the high eastern mountains the elevation decreases westward.

On Baffin Island large, blue, fresh water lakes have been found scattered among the barren rocks. Two large lakes are present in the southern part. Nettilling, the larger one, has flat shores.

The southeastern corner of Foxe Basin ends in a limestone

scarp front. The narrow coastal plain of this basin is of recent origin. Tides, which are twenty feet high, shift the shoreline. North of Foxe Basin, the interior is less than 1000 feet in elevation and has numerous lakes above which is glistening ice.

The northwestern end of Baffin Island is a low plateau with steep cliffs. Admiralty Inlet is a large deep bay suitable for navigation. At the head of the bay the land, which faces south, rises gently. Low mountains surround the bay. Navy Board Inlet is the other deep northern bay. Bylot Island has an elevation of 2000 to 3000 feet.

The landforms of Baffin Island, from north to south, show a decrease in the effects of glaciation. Today the glaciation on the island is not so continuous. The mountains of the north grow sharper. North of Cumberland Sound the ice cover is on the upland and the glaciers descend into the bays. To the south the upland is partially covered. Ice in the sound is kept open by violent tidal currents. The size of the water holes change with the moon and the tides. They make good hunting areas. The water holes decrease in the north because the tides are weaker. South of Frobisher Bay the Grinnell Ice Cap extends ninety miles.

Parry Islands consist of Cornwallis, Bathhurst, Byam Martin, Melville, Eglington, Prince Patrick, Brock, and Borden. They have some uniform character of rock. The thick white and yellow sandstones have coal pockets. The blue limestone of the north has marine fossils. The westernmost islands have steep shores 300 to 650 feet in elevation which have dissected the

interior plateaus. Melville Island is the largest of this group.

The Sverdrup Islands lie between the Parry Islands and Ellesmere Island. This area is one of deep faulting where some blocks were uplifted and others sank. Axel Heiberg Island is the largest of this group and has a north-south elevation of 1,650 feet. In the interior are low, rounded gravel ridges and sand banks of great thickness. Islands to the west of Axel Heiberg have a lowland character. Glaciation throughout the group is almost entirely lacking.

Devon Island is referred to as the connecting link between Baffin and Ellesmere Islands. Its eastern elevation is 3,280 feet. It has a thick ice cover which sends glaciers into Croker Bay. The adjoining plateau is lower and decreases in elevation to the westward until the ice finally disappears. The west coast rises abruptly to 1,000 feet.

Ellesmere Island is the largest island in the archipelago. Characteristic of this island are the pairs of indentations which mark the four natural sections. From south to north, increasing in size, they are Lincoln Land, King Oscar Land, Grinnell Land, and Grant Land. The land in general rises to an elevation of 2,300 feet. The ice cap in the southeast is continuous near the coast for the moisture carried in the winds blowing over Smith Sound nourishes the glaciers. The smooth, level surface of Craig Harbour is surrounded by higher and well drained ground that slopes to the southeast. Streams of good water furnish a drinking supply. Shallow water and glacial ice

have hindered the port development at Craig Harbour.

Grinnell Land, with an elevation of 5,000 feet, decreases in the southeastern part to 1,970 - 2,950 feet. The adjoining plateau, to the west, is lower, bordered by low, narrow plains. Grinnell Land is a large ice free area.

Hazen Lake (at 82 degrees N latitude) in Grant Land is large and contains fresh water. It lies south and parallel to the United States Range that has elevations to 10,000 feet. Explorers say it used to be a hunting paradise for the Eskimos who migrated or settled there. South of Hazen Lake is a depression where glaciation is extremely weak. Grant Land is another polar region free of ice. Northeast Ellesmere Island lies in a zone of folding.

Ellesmere Island had about the same amount of ice-cover when the Eskimos first lived there as it does today.

Climate

The position of the American Arctic Archipelago gives it a continental climate. Cold winters have very little temperature variation. Continental summer warmth is prevented because of the ice-filled channels. Summer warmth lasts for a three month period when the temperature ranges from about 32 degrees Fahrenheit in the north to 41 degrees Fahrenheit in the south. There is really no summer. During June and July the sun shines for twenty-four hours a day. In July the sea ice begins to break up and, in September, it is again frozen solid. The farther north, the colder the temperature. The American Arctic Archipelago has sub-divisions of the high arctic belt with the

exception of the southern portions of Baffin and Victoria Islands. Along the coastal areas the temperature for the warmest month is from 28 to 41 degrees Fahrenheit and, for the coldest month, the temperature is from -32 to -40 degrees Fahrenheit. At Cumberland Sound the winter temperature is -25 degrees Fahrenheit and the summer temperature is 44 degrees Fahrenheit. Port Kennedy, on Somerset Island, has a July mean temperature of 40 degrees Fahrenheit and a February mean Temperature of -37 degrees Fahrenheit. Victoria and Banks Islands have a winter temperature below -30 degrees Fahrenheit. Smith Sound has an unstable winter climate because southerly winds raise the temperature about 30 degrees within a few hours and rain takes place. A south or southwestern exposure gives places like Arctic Bay Post and Pangnirtung the warmth of the sun. Pangnirtung, in summer, has a dependable supply of fresh water.

Winds blow from the north or northwest bringing little precipitation. These winds are influenced by the barometric low of Davis Strait. Spring and autumn have misty rains, snow, and fog which handicap travel because of the melting water and slush. The scant precipitation of summer and winter prevents or hinders glaciation. The ice cover is caused by the nearby open water. Three-fourths of the archipelago is snow free all year. The north winds give the strait system a motion towards Baffin Bay. In narrow places the current is intense and keeps the water around North Kent Island permanently open. The low mountains around Admiralty Inlet reduce the severity of the

winds.

The temperature of Ellesmere Island is from -55 to -60 degrees Fahrenheit showing that a continental condition is present on the land. During the drift of the "Fram" a low temperature of -32 degrees Fahrenheit was recorded showing that sea temperatures are higher than land. The July mean temperature for Ellesmere Island is 37 degrees Fahrenheit and the coldest month mean temperature is -35 degrees Fahrenheit with a uniform temperature throughout. At Craig Harbour the average winter temperature is -55 degrees Fahrenheit.

On Ellesmere Island lies the pole of auroral frequency situated at 81 degrees N latitude and 70 degrees W longitude. It is 26 degrees east and considerably north of the magnetic pole.

Vegetation

Most of the vegetation on the north polar islands of the American Arctic Archipelago is poor. The amount of vegetation is determined by the cold, the winds, and the moisture. The ground has different effects on vegetation. In small, damp, protected places, there are oases. The soil is better in the east therefore the densest vegetation and the most abundant number of species occur there. The barren lichen tundra is not continuous because there are mosses, lichens, grasses, reed grass, and low shrubs. The southern part of the archipelago is considered tundra. In watered, isolated oases there is the Arctic poppy, saxifrage, and spoonwort. Since it has two hundred flowering plants the archipelago is considered com-

paratively rich in vegetation. The seeds are blown over the ice by the wind. Swamps and brooks are covered with algae that serves as food for geese and animals. Vegetation grows more sparse in the north but the interior northernmost vegetation is luxuriant because of the high summer temperatures.

The soil of Banks Island supports vegetation.

> "Here was a beautiful country of valleys very gold and white with flowers or green with grass or mingled greens and browns with grass and lichens, except some hilltops which were rocky and barren. These hills differ in coloring especially as seen from a distance, not so much because of the colors of the rocks as because different vegetation prevails in different kinds of soil and different lichens on different rocks".*

The plains of King William Island are moss covered.

There is little vegetation on Baffin Island. Barren rocks are black with lichens. The western plains and valleys have tundra carpets and the slopes occasionally have dwarf bushes and Arctic flowers. There are 100 higher plants in the south and 31 (including five saxifrages) at Pond's Inlet in northern Baffin Island.

Melville Island, in the Parry group, has sixty species of flowering plants. Axel Heiberg Island, in the Sverdrup group, has thirty-four flowering plants, fifteen mosses, grasses, and lichens.

On Ellesmere Island plant life decreases ever so slightly toward the north. Lady Franklin Bay is an Arctic oasis. The terraces facing south have vegetation in the form of the Alpine

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* THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking, p. 224.

poppy to an altitude of 1,950 feet. The grass on wide areas serves as pastures for the musk oxen. There are saxifrages, grass, and flowers. The plateau heights are bare or have some lichens. In the southern part the vegetation grows more sparse and less hardy towards the west. Altogether, Ellesmere Island supports 115 flowering plants and four hundred lower plants.

Animals

In the high arctic belt of the American Arctic Archipelago are large grass eating animals. They are more numerous in the northern and western sections and, they are found in still greater numbers near Eureka Sound.

The land animals of importance are the reindeer, musk ox, and caribou. In the spring the reindeer migrate across the straits in the archipelago. The musk ox roams the archipelago with the exception of Baffin Island. These animals run faster than man. As many as thirty musk oxen are found in a single herd. They pasture on the low, dwarfed vegetation which, for the most part, is grass. Their bodies are about five feet in length. The caribou migrate in the summer and are not found in the most northern part of the American Arctic Archipelago. Animals of prey are the wolf, Arctic fox, ermine, and polar bear.

Whaling is carried on in the sounds for six to eight weeks during the summer.

Birds such as gulls, divers, and snipes go to the northern limit of the archipelago. Colonies of sea birds are seen about North Water. Snow buntings and ptarmigans are the land birds.

Mosquitoes exist, but are rare on the islands.

On Banks Island the vegetation supports caribou and Arctic hares.

Caribou graze near the Nettilling and Amadjuak Lakes, and near Pangnirtung of Baffin Island. Along with the caribou there are hares, wolves, and foxes. In the large lakes are salmon and seals.

"In the north the abundance of fish in the waters is so great that over a thousand salmon have been caught in a net in an hour".*

Breeding grounds are most concentrated at the northern end and bird life is abundant there. The southeastern corner of Foxe Basin has a low marshy plain and serves as the breeding place of the blue goose. Along the coast of Baffin Island are varying kinds of seals, narwhals, white and finback whales, and polar bears.

Herds of musk ox and reindeer find good pastures on Devon Island. Walruses and polar bears are in Wellington Channel.

On Melville Island musk ox herds number about one hundred fifty. Additional animals are the caribou, wolves, foxes, hares, lemmings, polar bears, seals, and very few whales.

The musk ox has been seen along with the more numerous caribou on Axel Heiberg Island.

Animal life is abundant in places on Ellesmere Island.

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* THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking, p. 217.

There are musk oxen, foxes, wolves, hares, lemmings, and bears. Caribou is a summer visitor. Peary found a hibernating species of caribou in Grinnell Land that lives on lichens.

The guillemot, auk, and eider duck live along the coast and help to make the barren soil fertile. Land birds such as the snow bunting, snow owl, hawks, and ptarmigan are less numerous. Sea animals are narwhals and porpoises.

Inhabitants

A permanent population inhabits the American Arctic Archipelago. Eskimos live on Baffin Island and the southern parts of western islands. Inhabitants of the southern margin depend on the seal and bear for their livelihood.

On Victoria Island, Stefansson[56] found blonde Eskimos numbering 100 to 150. They had brown beards and gray green eyes that made them seem to have more half breed blood than pure strain.

Pangnirtung, located on Cumberland Sound in Baffin Island, has less than one thousand population. Baffin Island has a population of over 2,000.[57] The inhabitants are the Nachilli and others who have no contact with civilization. By bartering with southern tribes they receive iron knives and driftwood. They make bows and arrows of caribou bone. Their kayaks are ugly and awkward. The native Eskimos hunt, fish, and trap. Their chief pursuit is hunting the white Arctic fox. An annual

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56. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.
57. ENCYCLOPEDIA BRITTANICA 1945, based upon 1940 census.

whale drive begins in July. At this time they hunt a small white whale which is ten to twenty feet long. The skins and blubber are used for clothing, food, and fuel. Ship time comes late in September and then the Eskimos are in contact with the white man's world. Pangnirtung is a metropolis with a mission school, hospital, and whaling station. The center attracts white people because of its white fox furs. It is the most accessible settlement to white man and Eskimo.

The establishment of whaling stations at Pond's Inlet has diminished the number of natives and changed their mode of living. Their settlements and pathways have changed so that they no longer use just driftwood or soapstone. The northern tribe of Pond's Inlet hunt musk ox, walrus, and bear in the area which extends from Foxe Channel to Somerset and Devon Islands and Wellington Channel.

The native population along Foxe Channel has not changed. The number of natives here is about one thousand.

The southern tribes include those from, and south of, Cumberland Sound. At Cumberland Sound about four hundred Eskimos are in the employ of whaling stations. They also turn in bears, wolves, foxes, and walruses. There are three tribes along the southern coast. The middle tribe came into contact with the early discoverers. These tribes are drawn to the lake plain for summer hunting.

The inhabitants of Ellesmere Island were much the same 1,000 to 2,000 years ago as they have been for the last 200 to 300 years. The largest former Eskimo dwelling is Eskimopolis

on Hayes Sound. Sixteen of the abandoned winter houses have been found here. Craig Harbour is Canada's northernmost outpost. It is located on the southeastern coast of Ellesmere Island and is the only settlement on the island today. Because of its surface it could serve benefically for an aerdrome to aid in the defense of the Western Hemisphere. The population of Craig Harbour was not listed in the 1945 edition of the Encyclopedia Brittanica.

The islands of the American Arctic Archipelago are a political sovereignty of Canada. Canada foresees the profit to be obtained from the animals and minerals. There are two Royal Mounted Police Stations on Ellesmere Island, one at Craig Harbour and the other at Buchanan Bay.

These islands have an interesting anthropogeographic position because they connect the original home of the Eskimo with Greenland. This route is the smallest deviation from the coast route.

Minerals

Coal seams are exposed along the coasts and in the valleys at Mercy Bay and Banks, Southern Melville, Byam Martin, and southern Bathhurst Islands. Coal was first found by Parry on Melville Island.[58] Lignite coal is found in northwestern Melville Island. The value of the coal remains unknown.

Pitch was also found on Melville Island. It was used for

58. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

kindling and gum. Fossil wood has been found in the western part of Melville Island.

Martin Frobisher[59] discovered the iron ore of Baffin Island.

Greenland

Topography

Greenland, in the middle of the North Atlantic, is the largest island on earth and the largest Arctic land. It is broad in the north and narrow in the south. Major indentations and projections of this island are Melville Bay, Hayes Peninsula, Kane Basin, Prince Christian Land, and Peary Land. Greenland is an old land mass with folded mountains. There are real mountain chains which are elevated and deeply dissected and occur on the marginal zones of western and eastern Greenland. They are mostly ice-covered and yet, the largest ice free areas are here, too. It is believed that extensive, fairly level highlands lie under the ice.

Fiords and bays extend far into inland Greenland. The lowlands and coasts are important throughout. The nunataks of the marginal belt have four types of landforms. Hummocky rock is found in deep valleys, fiords, lake depressions, and lower hills. Frost action and resulting rock blocks have caused formation of the lowland areas of Greenland. The low rocky plains and strand flats are a characteristic of Greenland. The

59. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

Alpine forms are mountains towering above the hills. Trap rocks are uniformly high, steep, and terrace-bordered plateaus. They are present along the western coast and on Disko Island. Old moraines are strewn sparingly and have a dense vegetation.

Greenland's ice free area is about the same today as when the Eskimos first went there. About 187,500 square miles are ice free. During the last fifty years Greenland's permanent snow cover has been decreasing steadily from ninety per cent to eighty-six per cent, to eighty-two and eighty per cent. The snow-free land, larger than the whole of Great Britain, is treeless mountain and prairie.

The peneplain under the ice cap is bordered by sedimentary and volcanic rocks. Greenland has never been entirely ice covered because of its sharp peaks. There are two major forms of ice here. The surface conforms to the flat shield form of inland ice with no bed rock above the surface in the center. Its uniform shape and surface lacks all life. Shield form of ice breaks off in steps. The inland ice repeats the outline of the land and is not entirely independent of the sub-stratum. The southeastern and northeastern parts have high mountains. The high eastern elevation holds the backbone of ice. The ice sheet rises gently from the sides to a north-south divide which is nearer the high mountains of the east. The ice near the center of Greenland is about 8,800 feet in elevation which indicates that there is an interior basin with mountains on the east and west coasts. The mountain region, close to the east

coast and near the Arctic Circle, has an altitude above 11,000 feet. The small indulations on the inland ice are due to wind blown snow. In summer there are pools of melted snow between the indulations.

The second form of ice is the crevasse. On the west side of Greenland, near the fiords, the ice surface is broken by crevasses. Summer gives the ice surface at the border a different character. Water courses develop which erode canyon-like valleys and finally disappear into crevasses. This phenomenon occurs (1) where ice tongues extend into rocky valleys and melt from the radiating heat of the rocks to cause deep runways, (2) where melt water gulleys surround nunataks, and (3) where dust melts ice making shallow depressions like test tubes or the honeycomb ice of the west. The motion of the ice depends upon the melting and refreezing. Greenland's inland ice is fed mainly from the east and terminates in the west. The ice border in northern Greenland is steep; in the central and southern part it extends more gently to form icebergs. The location and elevation of Greenland's ice cap makes it possible for live glaciers to move out into the sea.

The central depression of Greenland, with its ice swamps, extends from Disko in the southwest, to Angmagsslik, in the southeast. Between these two points are large areas of basalt. The most productive glaciers are at the ends of the central depression.

The western coast has a lower elevation with more rounded

forms. The coast is almost ninety miles wide. Upernivik is a district of skerries. It is broken into rounded islands of moderate height. The vegetation consists of rock plants. Central west Greenland has broad round bays, peninsulas, islands, and in the rear are fiords. The region as a whole is an elevated peneplain 6,500 feet above sea level with rocky basins filled with lakes which makes it one of the most lake studded regions on earth. Rivers and brooklets are slight. The ice streams and Great Karajak Glacier, which is five miles wide, move from the inland ice to the sea. Western and northern Greenland are relatively free from ice. A warm arid region region inland from Holsteinborg has loess, a fine grained soil, deposited by the wind. The middle western coast has an independent mountain which is not reached by inland ice. This mountain has a few ice caps of its own which are brought down to the sea by the fiords. The wide bays along the western coast receive masses of inland ice. Melville Bay is almost entirely surrounded by an edge of inland ice. It is difficult to cross the ice-jammed bay. Nunataks rise from the ice in the north of the bay. Both the north and south sides of Hayes Peninsula have inland ice which reaches the sea. The inland ice on Hayes Peninsula divides into two lobes separated by Inglefield Gulf. The peninsula is a plateau 2,300 feet above sea level. The inland ice in the south enters Melville Bay and, in the north, it receives the name Humboldt Glacier. Icebergs calved from the sixty foot high front are floated away in the waters of Kanes Basin.

Northern Greenland is in a zone of folding. A recent uplift has made terraces 1,645 feet high. Peary Land has several long fiords which penetrate inland. The elevation of Roosevelt Range is 6,500 feet with an adjoining south plateau 2,600 to 2,950 feet high. Peary Land is broad and the greatest ice free land in Greenland.

The east coast of Greenland is more difficult to reach because of the southerly current which bears ice.

Northeast Greenland begins at Danmark Fiord. The most impressive fiord system on earth is in this section. There are Franz Josef Fiord, King Oscar Fiord, and Scoresby Sound which compares to a delta with its low, level, ice-free gravel plain. Icebergs run aground in the fiords and cause much pack ice.

A considerable area of northeast Greenland is ice free. The alpine formation has a predominating plateau elevated to 3,250 feet. The nunatak of Queen Louise Land rises to 6,500 feet and towers over the surrounding ice. Toward the north, the elevation lowers. Inland ice approaches the coast and, at 81½ degrees N latitude, the snow line is at sea level. It is the only place of its kind known in the Northern Hemisphere. Here there is piedmont glaciation and floating inland ice which sometimes ends in a very steep, high wall 100 to 130 feet high.

Central east Greenland lies between 68 and 76 degrees N latitude. It is a wider ice free land with deeper fiords. The three divisions along the coast are the northern section, the middle section with its gigantic fiords, and the southern section

at Scoresby Sound with short fiords. Scoresby Sound has hot springs with hydrogen sulphide. The heights are like plateaus.

Striped ground is a feature of Greenland's eastern coast. The striped ground, lying in the direction of the slope, has a more or less regular pattern of coarser and finer gravel and sand.

South of Scoresby Sound the landscape varies from lowlands to the greatest heights and with diverse coloring. The coast is narrow from Angmagssalik southward.

Southern Greenland's marginal region is, for the most part, a plateau girdled with skerries. Mountains, dissected by fiords and sounds, rise to 6,500 feet. Glaciers extend down the slopes from separate ice caps.

Because of Greenland's size, geographic position, and level-topped ice cap, it is a good base for ships and planes. Necessary weather reports are given for the proper operation of such fleets. Greenland's level ice cap is in use now for trans-Atlantic flying.

Climate

Greenland carries out the concept of a frozen north as set down in Greek philosophy. Greenland belongs to a separate climatic region and is classified as a genuine Arctic land.

Greenland's warmer climate is shown by fossil poplars, chestnuts, oaks, laurels, walnuts, and magnolias which once grew as a luxuriant forest.

The land mass of Greenland has mild winters and warm summers. Summer temperatures are cooler than the tundra parts

of Asia. Coastal temperatures are irregularly distributed. The mean annual temperature for Greenland is -25.6 degrees Fahrenheit. On the prairies or treeless mountain regions there is, every year, or once every few years, a warm spell when the sap flows as it does in May in New England. This is followed by nights that completely freeze every plant. The interior fiords are warmer in summer than in winter. In summer, vegetation develops and berries mature.

Precipitation is meager for there is less than ten inches annually. Low evaporation and low specific humidity permits the formation of Greenland's ice field. On the ice-free marginal belts there are clouds, fog, precipitation, and a decrease in wind velocity. The gales along the shore of Greenland are caused by cold air on the ice cap sliding down the incline toward the sea where it meets the lighter, warmer air. There is no northern wind as dangerous as a hurricane.

In Greenland the light of the aurora is said to exceed that of the moon. Auroral light is bright enough to cause objects to cast shadows.

Greenland's inland ice causes an arid climate and warm summers at the ice borders. The ice desert has sustaining precipitation. Hobbs[60] believes that some of the moisture over the ice cap is precipitated as hoar frost. The inland ice cap has a large daily temperature range and a bright sky. A dry, sandlike, granular snow covers the surface. The mean tempera-

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60. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

ture for the warmest month on the ice cap is practically always below freezing. The north-south median zone has gentle winds because of its remoteness from the margins. Because of this favorable climatic condition it would make a good place for airplanes to land. The air current from the interior blows into depressions causing fohn winds. These winds cause melting on the borders that form lakes, brooks, large rivers, snow marshes, and small melt water holes. Fohn winds, with their enervating tendencies, are most effective in winter and cause temperature changes that are more varied than those of summer.

Holsteinborg district, north of the Arctic Circle in western Greenland, has an unexpected, remarkable climate. West of the ice edge is a dry belt where there is less precipitation. This dry steppe region has lakes with no outlets which result in salt lakes and a saline efflorescence. Toadstool rocks are common in this region. Loess is carried and deposited by melting ice and streams and sand is blown by the wind. Winter snowfall is exceedingly light.

At Eismitte, Greenland, the average temperature is above zero but below freezing. Rivulets flow during the three summer months. In January and February the average temperature is -42 and -53 degrees Fahrenheit. The winter is free from storms and winds. The average cloudiness, in the least cold season, is .5 and .6. Clouds are stratus, cirrus, and cirrostratus. Precipitation is slight. During observations made here precipitation fell 204 days, but in twenty-one years the total

snowfall was only 12 inches.[61]

Disko Island has inferior climatic conditions due to the warm northerly current from the Greenland side and the cold southerly current from Grinnell Land. Precipitation falls approximately 165 days. Disko Island, with its south facing valley, has noticeably warm summers. Eskimo legend tells of a boatman who conveyed these warm summers from the south.

Upernivik, Greenland, in winter, is almost uniformly -8 degrees Fahrenheit and in summer, about uniformly 40 degrees Fahrenheit. The uniformity in temperature is noticeable as the pole is approached.

In central west Greenland "The wind and air pressure of a given summer in the region of these fiords determines the following springs quantity of drifting icebergs even so far south as Newfoundland".*

Inglefield Gulf of northwest Greenland lies in the high Arctic belt where the warm month temperature is 41 degrees Fahrenheit but not below 32 degrees Fahrenheit.

North Greenland has ice and snow on land and ice-girded coasts. Winter temperatures like those on the coast of Greenland are experienced in one-half of the United States. In northwestern Greenland, eight hundred miles north of the Arctic Circle, the temperature is -42 degrees Fahrenheit. Cape Morris Jesup, located at the north tip of Greenland, has a winter

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61. THE INTRODUCTION TO WEATHER AND CLIMATE, Glenn Trewartha.
* THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking, p. 262.

temperature falling sometimes to -60 degrees Fahrenheit. Peary Land has moist summers caused when the snow melts under a July mean of 35 degrees Fahrenheit and forms rivers and lakes. In the farthest north, no place has a summer mean temperature below freezing. For this reason plants and animals are profuse. Northern Greenland has a meager precipitation and resultant aridity.

The climate of eastern Greenland is almost continental in the north and moderates southward and seaward. Summer can bring great warmth with a July average temperature of 40 degrees Fahrenheit at Scoresby Sound. The February average for the same locality is -12 degrees Fahrenheit. North and northwest winds are more frequent and violent in the winter. Large stones are rounded on the north side and snow has a parallel pattern due to the effects of the wind. East winds prevail from May to July and bring moisture and fog. Precipitation is greater on the east coast than the west. Summer comes by sudden transition.

The low pressure paths are along Davis Strait and past Iceland influencing the southern part of Greenland. The low pressure area determines the winds on the coast. Heavy precipitation and high humidity are features of southern Greenland. Ice is probably formed because of the high precipitation, the free direct land connection with northern Greenland, the temperature, and condensation. The southern end scarcely attains the July average temperature of 50 degrees Fahrenheit.

A permanent polar station has been established in Greenland for the purpose of making weather observations. Greenland has

a strategic position for weather forecasting to benefit countries east of her position. Important use is made of radio sending apparatus for weather reporting. Airplanes drop supplies and their motors and propellers are used to pull sledges.

Vegetation

Vegetation differs in the various parts of Greenland. Forests grow in the protected places at fiord heads in the southern part. Beyond 70 degrees N latitude luxuriant bush vegetation with heaths and meadows are occasionally found. There are about 420 vascular plants in Greenland one hundred of which are known north of Melville Bay.

As summers grow colder, vegetation becomes sparser. Vegetation retreats from the cold, windy outer margins into the fiords. Dwarfed trees, shrubs, herbs, grasses, mosses, and lichens give a varied vegetation. Plant life just tinges the background of rock. It is believed that all species have migrated from Europe or America.

Along the west coast, Holsteinborg has a scanty vegetation probably due to the aridity of that area. Disko Island's south facing valley has, along with about two hundred species of higher plants, a forest of willows and birches as tall as man. Willows grow as far north as 73 degrees N latitude. Northward to Upernivik, herbaceous vegetation occurs with dwarf birch and willow. Vegetation of central west Greenland develops in mid-June. The rocks are black, red, and green with lichens. There are grasses, mosses, flowers, rhododendrons,

saxifrages, and poppies. Water pools are surrounded by bulrushes and cotton grass. By late June the crowberry, whortle berry, white bell, wintergreen, sedge, white rosemary, yellow poppy, small white rose, red and pink saxifrage, red or white lousewort, and rose-red willow herb blossom. In the middle latitudes of Greenland bush and meadow predominate. There are also brown heath and juniper. The swamps are moss covered in summer and the hummocked rocks have a few black lichens. North of Disko Island there are bushes, meadows, heaths, and marshes in small patches. Here rock vegetation predominates with isolated bushes, shrubs, mosses, lichens, and flowering plants.

At Hayes Peninsula, vegetation is more abundant on the Greenland side. Foulke Fiord at Etah has seventy-five species of growth. Thick, grassy carpets of mosses surround the small mountain lakes. The south and southeast valley afford room for plant and animal life. Inglefield Gulf separates the two halves of Hayes Peninsula and, on its borders grow, low grasses and shrubs. Northwest Greenland has about 130 species of phanerograms.

In Peary Land, there are about 108 flowering plants which mature in one month. Grasses, Arctic poppies, and saxifrages provide a luxuriant vegetation on which the animals graze.

Northeast Greenland's vegetation consists of nearly one hundred species of flowering plants. Some of these are the crowfoot, saxifrage, and whitlow grass. Places with more moisture have mosses and grasses. Where there is dry gravel, growth is more sparse.

In central east Greenland, the vegetation is more luxuriant. This coast is in the latitude of Disko Island. Here grow 176 species of flowering plants for there is more ice free soil here than farther south. There are grass carpets, mosses, lichens, heathers, stunted bushes and flowers, dandelions, and cinquefoil. There is no forest growth.

Coasts along the southern half of Greenland have a polar-tundra type of vegetation. The southern end has three-fourths of the four hundred higher plants found in Greenland. This abundant growth consists of birch forests, dwarf junipers, shrubs, grasses, and flowering plants. There is very little plant life on the bare skerries in the southern part of Greenland. Inland, along the fiords, grow willow forests, birches twenty feet tall, alders, and mountain ash. Northward, along the west coast, are found bushes, grasses, dwarf heathers, moss moores, rock mosses, lichens, and isolated shrubs and bushes. Julianehaab, situated in the extreme south, has a government agricultural experiment station.

Animals

The animals of Greenland are confined to the ice free areas and the number of species is greater in the north than in the south. Reindeer, hare, and fox are almost everywhere in the ice free areas. Reindeer herds have been reduced by the use of firearms. Now it is felt that the area should be restocked. Foxes are hunted during the winter in southwest Greenland. On Hayes Peninsula, reindeer find a good pasture, and foxes, especially the blue fox, are known to live here.

There are also polar bears, wolves, hares, and musk oxen. Herds of musk oxen number about two hundred because of the favorable grass growing conditions. In the winter, all the animals cross Smith Sound. The polar wolf and the musk ox are the newer animals in Greenland.

Musk oxen live only in northern Greenland. Reindeer that were formerly numerous in this section are now diminishing. Musk oxen range the farthest north.

"Even in the meager meadows of northern Greenland this bovine species is able to dig out its food from the thin cover of snow. But it is restricted to the American sector and the eastern side of it".*

In east and northeast Greenland, the musk ox, wolf, reindeer, lemming, hare, fox, and ermine find good homes. This wild life is not found south of Melville Bay or Scoresby Sound.

The seal is the mammal most valuable to Greenland. It inhabits all the fiords. In the southwestern part of Greenland, the drifts of the Greenland Current bring favorable sealing conditions. In this section are found the hooded seal, Greenland seal, humpbacked whale, and swordfish. Great herds of seal and walrus compose the sea life of Hayes Peninsula. Halibut and sharks are found around icebergs. Salmon are in fresh water. In Peary Land sea life consists of polar bears, bearded seals, the Greenland whale, narwhal, the white fish,

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* THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking, p. 119.

and walrus. Northeast Greenland's sea has the high Arctic walrus, the fiord and Greenland seals, and polar bears. Annual hunts to obtain the skins of seals, polar bears, and Arctic foxes center about Angmagssalik.

Commercial fishing in Greenland became important in 1906 under the aid and supervision of the Danish government. The principle fish are cod, halibut, Norway haddock, salmon, caplin, and Greenland shark. The catch is usually taken to stations and canneries.

Birds are abundant along the coastal areas of Greenland during the summer. They all migrate in winter. Birds of Peary Land are the snow bunting, snowy owl, gull, and snow goose. On Hayes Peninsula, there are large flocks of dovekies, gulls, guillemots, and petrels which fertilize the soil and promote vegetation. Other birds are hawks, ravens, fulmar, eider duck, and ptarmigan.

Mosquitoes are found south of Disko Island and north of Melville Bay. Around Hayes Peninsula are bumblebees, butterflies, and mosquitoes. In northern Greenland, 440 species of insects are known of which the majority are flies and mosquitoes. There are fifty species of butterflies, many beetles, spiders, and bumblebees. The northeast area has the same insects and mites, too.

Inhabitants

The ice free strip of Greenland is inhabited by man who is believed to have come from the Barren Grounds across the American Arctic Archipelago to northwest Greenland or across

Melville Bay in pursuit of the musk ox. More research about the Eskimo migrations is needed to validate these theories. According to prehistoric accounts, the Eskimo people of Greenland probably crosses the ice of Bering Sea on foot as they traveled from the Asiatic coast to Alaska. They kept to the northern coast and traveled eastward because the land was free of snow each summer so that there was good pasture for musk oxen. It was impossible to move south or southeast because of the glaciated mountains. Eskimos settled permanently wherever game was plentiful and recurrent for they depended upon seal, walrus, caribou, fish, and birds. During the first half of the twentieth century the whole west coast of Greenland was inhabited from Cape Farewell north to Melville Bay. Greenland's Eskimos today include those south of Melville Bay, the Etah Eskimos of Smith Sound at 78 degrees N latitude, and the Eskimos at Angmagssalik. The uninhabited gap lies from Holm Island to the most southerly dwelling of the Polar Eskimo. The Norsemen found no Eskimos on the southwest coast but they did find ruined dwellings and utensils. More information about the early culture of the Eskimo is needed.

Both Stefansson[62] and Nansen believe that the Eskimos and early Norwegians have intermarried. The Norsemen, outnumbered by the Eskimos adopted their way of life. White men migrated northward where it was, by nature, a better hunting ground and his contacts with the Eskimo became closer. The Eskimos' flesh

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62. GREENLAND, V. Stefansson.

diet prevented rickets. The Norwegian learned that, if he lived like an Eskimo, his health would be better. Much obvious white blood is present in the Greenland Eskimo who, today, is attractive and fair. Greenland has had more European influence than any other Arctic area in the world. These Eskimos have been in contact with white men for centuries and are nearly Christianized.

The population of Greenland in 1921 was 14,350[63] and in 1940 it was 17,500.[64] There were about 500 Europeans included in this count. The population has increased by racial intermixture but the fertility of the pure Eskimo is small. The saturation point of the Eskimo race and Greenland's population has been reached. Fourteen thousand Greenlanders are half-breeds. The Etah and Angmagasslik Eskimos are probably the only natives with pure blood. The Etah tribe, on Hayes Peninsula of Smith Sound, have been influenced by the whites. Fundamentally, the Greenland race is sound and strong. Weak children die in the early years and some are even drowned by their parents. Hysteria, induced by an excessive meat diet, is common among northern and eastern Greenlanders. Greenlanders of an Eskimo race are cheerful, quiet, calm, patient, genial, companionable, slow of speech, and lively in gesticulation. An Eskimo, according to his ethics concerning conversation, will always agree with anyone who questions him. By evidence, the

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63. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.
64. GREENLAND, V. Stefansson.

inhabitants of Greenland were much the same kind of people 1,000 - 2,000 years ago as they have been the last 200-300 years. The health of the Greenland Eskimo is fairly good. Tuberculosis is the most prevalent disease. Tooth decay afflicts Eskimos who eat too much white men's food. The Danish have established medical service and quarantined the island against epidemics. They require the natives to retain their native habits and food.

Snowhouses were probably not possessed by Greenland's first inhabitants. Possibly snowhouses were first used by dwellers living between the Mackenzie River and Hudson Bay. Knud Rasmussen[65] says they were introduced in Greenland by a migration of Eskimos from Baffin Island within the last two hundred years. Dwellers between Melville Glacier and Peary Land know the snowhouse for they are descendants of the later migrants.

The Greenlanders low winter dwelling is built of stone or turf with some wood. Their winter homes are more permanent because of churches, schools, and trading posts. In summer, while hunting, they lead a camping life. European culture has been introduced. The natives now use feather beds, stoves, much tobacco, and coffee. Alcohol is not distributed officially, In many ways these people still follow such unwritten laws as those pertinent to the division of the spoils of the chase. Kayaks and dog sledges are irreplaceable. The kayak is con-

65. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

sidered to be a very safe, light-weight boat. Early Eskimos also used the kayak along with their larger umiak which was similar to a dory. The umiak was used for long journeys and is fast becoming obsolete. In the south, the inhabitants' livelihood depends upon the kayak but the mortality, by drowning, is greater here. The Greenland dog is used to pull the sledges in the northern section. Imported dogs are prohibited as only the Greenland dog is valuable for his running endurance.

The Etah Eskimos endure and enjoy the long winter of their polar environment. Dog sledges and ice hunting are a means to their survival in winter for they catch seal, white whale, narwhal, and walrus. They hunt for musk ox, polar bear, and reindeer. They are poorly acquainted with reindeer hunting and salmon fishing. Depots keep the food frozen until it is needed. In winter, their one room igloos constructed with a sod covering over rocks provides them shelter. Sometimes the rocks are covered with skins. While on winter journeys, they build snow huts. Tupiks of seal skin, very much like a tent, give them a temporary summer home. The heating and lighting in these homes is provided by the oil lamp which is fed by blubber. The Etah Eskimo has a poor supply of wood and meteor iron which, when bound together make their weapons and boats. Dog sledges are made of driftwood and whale bone or ivory. They have no bows and arrows. Early Etah Eskimos had no kayaks. Today these boats are made of driftwood and whale bone decked over with raw seal skin. Thule is their present trading station. Their fur clothing is made of bear skin. Soft under-

clothing is made from the skins of dovekies. The location of the homes of the Etah tribe is determined by wind direction. These Eskimos have assisted during scientific expeditions and were found to be excellent helpers, courageous, and self-sacrificing. In 1922[66] several of the Etah tribe succumbed to influenza.

Archeological research for relics of early colonization in Greenland remains undone. Some very interesting discoveries have already been made. In central east Greenland, settlements of old Eskimo winter houses have been located.

The chief occupations of the Greenlanders are whaling, hunting, sealing, and fishing. In recent years, some of the inhabitants have turned to sheep raising. Formerly, blubber was the chief article for trade sought. Today, blue and white fox skins, eider down, walrus skins, seal skins, feathers, salted codfish and salmon, salted halibut, and salted mutton are other items of exchange. In Greenland, the Danish exchange products on a cash and credit basis.

Eskimos were found in Greenland by the Icelanders about 982.[67] Greenland was colonized in 985. The most active period of colonization came to a close in 1006. Large scale immigration lasted less than 150 years. Greenland's republic lasted from about 990 to 1261. Today Greenland is an outstanding example of good progressive colonial government in

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66. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.
67. GREENLAND, V. Stefansson.

polar lands. A republic has existed for 271 years. Danish control over all of Greenland came in 1916.[68] Norway protested for she wanted a share of the northeast coast. As a result Norway was granted trading, sealing, hunting, and fishing rights. Greenland is ruled by a small Danish official staff. There are less than three hundred whites in Greenland. Greenland has felt European influences because of discoverers, scientists, government officials, and missionaries. The south coast of Disko Island has served as a station for research in natural sciences from 1906. Godhavn, situated on Disko Island, is the capital of North Greenland. It has a rock bench, an excellent harbor, and raises sledging dogs. Godhavn had a population of 447 in 1940 by the J. C. Winston Encyclopedia. The first Danish colony was founded by Hans Egede at Godthaab and colonization spread north and south. Godthaab was first colonized on Hope Island in 1721. In 1940, the population was 1,300 according to the 1945 edition of Encyclopedia Brittanica 1479 by the J. C. Winston Encyclopedia. Godthaab, the capital of South Greenland, appears prosperous and has fiords that don't freeze.

The settlements of central west Greenland are based upon the amount of seal. The twelve districts contain the sixty-two communities of the west coast. All districts are directed by natives. The region of densest colonization is between Cape Farewell and Cape Desolation with a 1940 population of 2,500

68. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

according to the 1945 edition of Encyclopedia Brittanica and 3,803 according to J. C. Winston's Encyclopedia. The largest settlement is Julianehaab which was first settled in 1775. Harbors of Frederickshaab (settled in 1742), Sukkertoppen (settled in 1761), and Holsteinborg (settled in 1760), each have a population of 300 to 600. Jacobshavn (settled in 1741) has a population of 400. Claushavn is smaller. Christianshaab (settled in 1734) has a small population and is noted for its harbor. Egedesminde (settled in 1763) and Umanak settled in the same year, have a few hundred inhabitants. Upernivik (settled in 1772) has a population of 200 and a trading post. Ritenbenk was settled in 1755. There are a dozen smaller settlements of which Itivdliharsuk is the most northerly. Northwest Greenland has many semi-permanent settlements of whites in Hudson Bay Company Posts because a variety of game is lacking.

Rosenvinge Bay was settled in 1924. William Scoresby[69] carried out the project by bringing in ninty Eskimos from West Greenland and Angmagssalik. This settlement has been successful and the Eskimos have plenty of seal, narwhal, and walrus.

Angmagssalik is the only settlement on the east coast of South Greenland (population of 768 in 1940 according to J. C. Winston's Encyclopedia.) High mountains form the background for this settlement. The Danish trading station has had some influence upon the civilization.

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69. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

According to Encyclopedia Brittanica of 1945, the total population of Greenland was 18,200; a native population of 17,800, and a density of .02 persons per square mile.

The social progress of Greenland is more advanced. The education of the Greenlander is carried on by Danish teachers under the tutelage of the church. In 1936 there were 3,125 enrolled in the 109 schools.[70] The people are educated in two languages, Eskimo and Danish. It is difficult for a European to learn the Eskimo language. Henry Rink[71] began circulation of the newspaper which is edited and printed by Eskimos in the Eskimo language. The newspaper is freely distributed because it is financed by the South Greenland Community Fund.

Minerals

Greenland is the least developed commercial area in the Arctic. Coal, marble, meteor iron, cryolite, and rare earth minerals are being used. Coal has been located on Disko Island and the mainland. The extent of the strata remains unknown. Etah Eskimos use meteor iron for their weapons though this metal is scarce. Rare earth minerals are numerous but not in sufficient quantities to support an industry. The cryolite mine in the Danish colony of Ivigtut is one of the most northerly of the world's largest mines. Its self-supporting royalties are the principal source of revenue for Greenland. This is the only known locality where cryolite occurs in

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70. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.
71. Ibid.

commercial quantities. The mine is situated at 61 degrees N latitude in a basin on the walls of a fiord more than 1,000 feet from the sea. The ore is mined by an open cut and sorted, by water, during the season from April to November. This flouride mineral is used as a flux in the manufacture of aluminum. Eskimos discovered it would melt in a candle flame. An American company, The Pennslyvania Salt Company of Philadelphia, owns and operates the mines.

Iceland

Topography

Iceland lies in an area of greatest vertical movement. The ruggedness of the surface is due to volcanic eruptions and earthquakes. The average elevation of Iceland is 1,300 to 2,500 feet with recent craters attaining elevations of 7,000 feet. Some volcanoes are still active and when they erupt beneath an ice cap there are dreadful floods. Immense glaciers are over 5,000 square miles in area.

Climate

Because Iceland is located between 63 degrees N latitude and the Arctic Circle, in the North Atlantic Ocean, it has a constant struggle between polar and Atlantic influences and there are many storms. Winters are mild whereas the summers are too cold for vegetation growth. Wind hinders tree growth. An excessive precipitation falls as rain and snow. The temperatures make the climate good for intellectual activity.

Vegetation

Cold summers prohibit vegetation except for Arctic lichens and mosses. Around the coast and lower valleys there is a belt of grass. Very few trees are able to withstand the icy wind therefore tree growth is almost negligible.

Animals

The inhabitants of Iceland maintain themselves by the essential agricultural occupations. Horses are used in transportation. There is usually one horse for every two inhabitants. They raise 30,000 cattle and 627,000 sheep. Agricultural exports are frozen mutton, sheepskins, and wool. Iceland is a source of eiderdown.

Cod and herring are the principal fish caught along the coast. The waters are full of fish and they are easy to preserve in a cool climate.

Minerals

Iceland spar, a calcite, is exported. It is hoped that the deposits of iron ore and sulphur will be developed in the future.

Jan Mayen

Topography

The smallest and most isolated Arctic island is Jan Mayen. This rocky island holds a volcano which belongs to the Arctic's highest mountains. Beerenberg volcano, still slightly active, has a summit of 8,200 feet above sea level and its main craters are ice filled. The soil is sandy and of recent lava type.

The southeastern side receives an accumulation of driftwood along its sandy coast.

Climate

Jan Mayen has the sea type polar climate. Drifting ice brings warmth. Jan Mayen rarely has its first sea ice appear before Christmas. Ice is greater in April and May and sometimes it lasts through June and July. The average temperature for the coldest month is -26 degrees Fahrenheit and the warmest month is 38 degrees Fahrenheit. There are frequent fogs. On the west and south sides the island has a higher temperature than 41 degrees Fahrenheit. The lowland area is ice free. Few colds and little sickness develop here. A permanent polar station has been established. A forecast of the sea ice was given by the station in 1921-1922 by the Norweginas.[72]

Animals and Plants

Life is scant due to the soil and winds. Vegetation consists of 40 species of flowering plants, mosses, lichens, fungi, and algae. Animals are the Arctic fox and sea birds. Whale fishing was carried on in the early seventeenth century.

Bear Island

Topography

Bear Island lies on the edge of the Barents Sea shelf in a zone of folding. This island is divided into two parts. The plain in the northern two-thirds adjoins a plateau which falls

72. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

off into the sea in the south. The highest elevation is about 1,760 feet above sea level. No glaciers are present on its surface. The soil is flowing because it is permeated with moisture. Bear Island has no good harbors. It is surrounded by ice for a half year.

Climate

Desolate Bear Island has a changeable climate because it lies between warm and cold waters. Cold summers are caused by the drift ice. 38 to 41 degrees Fahrenheit is the July temperature accompanied by almost constant fog. Since it is situated in the storm path of the North European Sea it receives a heavy surf.

Plants, Animals, and Inhabitants

This island is generally bare with oases of green moss, polar willows, whitlow grass, crowfoots, saxifrages, various grasses, and in other plant life that number less than 50 species. Fulmars and guillmots are birds which visit the island. In the summer of 1923 the population was 260.[73]

Minerals

The economic value of Bear Island is in its coal which is suitable for coking. Two hundred million tons of coal are available to Norway who claims control of the island.

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73. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

Spitsbergen

Topography

The archipelago of Spitsbergen is the best known of polar lands. In general, its surface is of snow and ice and barren rock. The archipelago lies on the European continental shelf and consists of West Spitsbergen, the main island, with a fiorded coast; Prince Charles Foreland to the west; Northeast Land to the northeast; Barents and Edge Islands to the southeast; King Karl Land further east, consisting of King Karl Island, Swedish Foreland, and Abel Island; and Hope Island, southeast of Edge Island. The general structure of Spitsbergen is that of mountains with glaciers extending to the coast. The moderately high mountains rise from 3,800 to 6,200 feet. Once glaciers were heavier than they are now.

Spitsbergen, 350 to 680 miles north of Norway, lies in a zone of folding. Its west coast has been folded. The eastern region is a uniform old faulted plateau with steep bare slopes older to the north and younger to the south. Many deep fiords and bays indent the north and west coasts.

The coastal and fiorded plains rise from sixty to one hundred feet above sea level with a varying width of one to four miles. Driftwood is abundant on the north and west coasts. Spitsbergen's strand flats or low rocky plains are caused by the frost action on the surface of the ground which allows rock block formations. Along with this angular detritus the ice free ground is characterized by polygonal soil, stone rings and nets, flowing soil or solifluction, and ground ice

probably formed from ground water. During the thawing period, water permeation makes the valleys impassible. Some of this water gathers to form fresh water ponds devoid of fresh water fish.

Sedimentary tableland and volcanic sheets are present in eastern Spitsbergen. A uniform plateau 1970 feet above sea level forms the interior. The plateau surface is covered with ice, snow, and angular rocks. Valleys and fiord heads separate the plateau. De Geer[74] refers to these plateaus as "quarters". In the northwest corner and along the eastern coast are dome-like plateaus. Local volcanic domes and hot springs with temperatures 82 degrees Fahrenheit exist.

West Spitsbergen with its area of 15,200 square miles is ice covered throughout the year by mountain glaciers and frozen water. West Spitsbergen's mountains are of secondary importance. The recent uplift, 425 feet, above the plains has developed high narrow terraces. Because of Spitsbergen's location and surface cover, it serves as a base for Arctic flyers.

Climate

The archipelago of Spitsbergen receives the beneficial effect of the Gulf Stream. In West Spitsbergen a great part of the plateau land on the fiords is ice free. Harbors here are open for four months especially in the north. Whaler Bay is always open. The average mean annual temperature is 14 to 18

74. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

degrees Fahrenheit. The summers warmest month is below 41 and 39 degrees Fahrenheit except on its south and west coasts. The fohn wind may raise the temperature to 50 or 59 degrees Fahrenheit. Ice remains the characteristic feature even though the ground may thaw six to two hundred thirty feet. The surface usually thaws to an average depth of two feet in summer. King Karl Land, east of Spitsbergen, has the same higher temperatures on its south and west coasts.

The coldest period comes between February and March when the temperature falls to -4 and -13 degrees Fahrenheit. The temperature often goes to -50 degrees Fahrenheit during Spitsbergen's long, cold, windy winter.

Winds cause great irregularity in Spitsbergen's weather. They vary greatly in a small space of time because of low atmospheric pressure and frequent fog which form by the mixing of warm sea air and the cold land air. Precipitation , although little, falls more on the west coast. It seldom rains in summer months. The eastern side is drier, clearer, and cold in winter.

Northern Spitsbergen has 135 days of daylight in a year. Radiation is heightened by the clear atmosphere and is the most powerful from 10 A.M. to 2 P.M. Streams flow down glaciers during periods of radiation. By October there is no sun, just twilight. As winter months approach, northern lights and moonlight often last for twenty-four hour periods with such brightness that sleeping is difficult. The sun returns in March.

A permanent polar station for observing weather has been established here.

Vegetation

Plant life of Spitsbergen is more abundant in the sheltered interior fiords of West Spitsbergen where flowers, green grass, and thick mosses grow. No trees or shrubby growths thrive. Although vegetation, throughout Spitsbergen is poor because of the cold summers, the few varieties amount to 125 vascular plants and 22 species of grass. Plants are found in the moors and swamps of the flat upland depressions. On southern exposures, where the water trickles down, there is a wide range of species, size, and color. There are beds of red saxifrage, mountain anenomes, woody shrubs, and poppies everywhere. Grasses and reeds grow on taluses and moraines. Mosses and lichens, dotted with some flowers, grow in the wide grass and tundra lowlands. Some valleys serve as reindeer pastures. Plants are scarce in the interior but vegetation is not confined to the bases of mountains for reindeer browse at 1,500 feet. It takes three months for a plant to complete its cycle. They flower in a six day period. Most of the flowers belong to the European-Asiatic group.

Animals

Spitsbergen lies within the Arctic fishing area and serves as an excellent base for such an industry. The archipelago gained its early commercial importance because of its many whales. Green Harbor has the whaling station which supplied whale oil for illumination before the introduction of kerosene.

Other sea animals are the seal, walrus, narwhal, finback whale, blue whale, and schools of porpoises. The number of seals and whales has been seriously reduced by centuries of hunting. Along the east coast of Spitsbergen are polar bears and white Arctic foxes which are uncommon elsewhere in the archipelago.

The land animals are the gray fox and reindeer. Reindeer herds are in the east away from man and in the wide green Sassen Valley of the west coast. Three-fourths of the bird life of Spitsbergen's coast breed there in summer and migrate south in winter. There are geese, ducks, guillmots, terns, and divers each with its rock shelf for a nesting place. Birds of the interior are few. They are gulls, geese, ptarmigans, and snow buntings. Gulls remain on the steep mountain walls away from the foxes. Their droppings make plant life luxuriant so that it attracts reindeer. Ptarmigan winter in Spitsbergen and easily procure their food from under the snow.

Inhabitants

Seven small settlements have been built on the west coast of Spitsbergen. Longyear City, on the southwestern side of Advent Bay, has a summer population of 400. The people who live there the year round are those employed by mining concerns, those who operate wireless stations and carry on scientific investigations, and an occasional trapper or fisherman. Inhabitants number 2,700 according to the 1940 census of the World Almanac. Transportation here is by dog sledge and skiis. These settlers are served by regular mail steamers and wireless

stations.

Spitsbergen was given to Norway in 1919 by the Allied and Associated Powers. In 1920, by an agreement in the Versailles Treaty, Norway received Spitsbergen with the provision that it was not to be fortified. In 1941 it flew the Norwegian flag.

Minerals

Coal of Spitsbergen has been known and used by whalers since 1610. Swedish geologists were the first to survey this coal. It has been systematically mined for the last twenty years. The yearly production has been 300,000 tons and all of it goes to Norway. The large coal reserves are estimated to be 9,000,000,000 tons. In appearance and composition it resembles the excellent quality of true anthracite. In one place the seam is almost 40 feet thick. There are several advantages for the mining of this coal. It is easily accessible because of its nearness to the coast. Frozen sub-soil gives advantages for the mining of this coal. Instead of timbering up the mine water is sprayed into the crevasses where it freezes. Men work better in a cool mine. The below freezing temperature with pure fresh air is good. There are no difficulties regarding fire or water. The coal mine near Advent Bay is bored and cut by electricity. It is a busy place during the short summer season. Coal boats are loaded from July to September. Fourteen mining companies come from England, Sweden, Netherlands, and Norway. The latter is the most active.

Other minerals of value, but not yet mined, are a low

grade iron ore, copper, lead, gypsum, asbestos, and marble. Conditions would indicate that petroleum will someday be found here.

Franz Josef Land

Topography

Franz Josef Land is composed of sedimentary tableland and volcanic sheets 12,500 square miles in area. These platueas, for the most part, are ice-covered. This group of islands lies the farthest north of all polar lands. Franz Josef Island group is twice as long from east to west as from north to south. The islands are divided into three sections by the British Channel and Austria Sound. Zechy Land, in the middle section, is composed of many small islands. Wilczek and Graham Bell Islands, along with several smaller islands, lie to the east. Alexandra Island, the only large ice-free land, and Prince George Island, the largest in the archipelago, are to the west along with many smaller islands. Cape Flora is located on Northbrook Island in the west group. On Alexandra Island the lowland is sixty-two miles long and five miles wide. White and Victoria Islands lie on a presumed submarine ridge. Both Islands are ice covered with altitudes of 820 and 490 feet. The walls of the islands are very steep with their lower parts more rounded.

Climate

Franz Josef Land has a sea type of polar climate due to the unbroken ice condition. The ice caps on the archipelago

are not very thick. Nunataks and coastal cliffs are not ice-covered. Conditions favor glaciation. Moisture for building glacial ice, is due to the position of the islands at the edge of the North Atlantic atmospheric depression and the Arctic high. Winds from the east predominate during the long cold period, and winds from the west during the warmer period. Storms and fogs are frequent. The small precipitation falls as snow. Ice-free stretches face north and west and leave the west coast ice-free for one month.

In the warmest month the temperatures register below 41 or 39 degrees Fahrenheit and ice remains. The mean temperature for July is 32 to 36 degrees Fahrenheit. On the southern and western coasts the temperatures are higher than 41 degrees Fahrenheit. Because of the sea type of polar climate the winter temperature is -22 degrees Fahrenheit with the lowest annual minimum between -40 and -50 degrees Fahrenheit.

Vegetation

Franz Josef Land has a sparce vegetation because of its far northern location. About twenty-three to twenty-five hardier species of phanerograms are known. Vegetation is more abundant on the western and southern coasts with mats of lichens and mosses; saxifrages and grasses. Cape Flora, a grass plain, is on Northbrook Island, in the west group.

Animals

Marine animals found on Franz Josef Land are the polar bear, seal, and walrus. No land animals are present but there are twenty-one species of birds. Cape Flora is visitied by

birds.

Inhabitants

Franz Josef Land had one of the first settlements made during the first Five Year Plan. A radio station and meteorological observatory were started in 1929. This land also serves as a base for advance on the North Pole. Cagni's latitude record of 86 degrees 34 minutes N latitude in 1900 was made from this base.

Novaya Zemlya

Topography

Novaya Zemlya is a double island broken by Matochkin Shar. Its position was first made known by Barents.[75] The islands are divided into three parts. The southern part of the southern island is low and flat with many rivers and lakes but no glaciers. From Admiralty Peninsula to Matochkin Shar, the northern half of this island has higher land. Deep transverse valleys and fiords cut into it on both sides. The southern boundary of Matochkin Shar has an elevation of 590 feet. In the northern part of the island glaciers begin to appear. The southern part of Novaya Zemlya is the continuation of the deeply folded mainland axis of Pai-Khoi, a branch of the northern Urals. The west coast is steeper, rockier, higher, and more broken than the east coast which slopes off, becoming low, flat, and uniform. The western side has a low foreland along with

75. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

the narrower, more prominent places of both coasts. Ice, on Admiralty Peninsula appears as a small isolated glacier of the Norwegian or plateau type.

Ice is characteristic of northern Novaya Zemlya. The northern part of this island is covered by continuous ice. The east has the thickest ice while, in the northwest, the ice front reaches the sea. Great Ice Cape is situated at the extreme northern end. Everywhere recessions are evidenced by the presence of moraines and lakes which lie in front of the glacier. Although the west coast of the northern section of Novaya Zemlya is not uniform, it is smooth. The eastern side is more uniform than the western and, farther north, the indentations become greater.

Climate

The two coasts of Novaya Zemlya have contrasting weather; damp on the western side, clear and dry on the eastern. The western and southern coasts have temperatures above 41 degrees Fahrenheit accompanied by frequent, dense fog. The weak currents of the Barents Sea and Kara Sea effect the climate and life on the east coast. Driftwood and ice collect there from the Siberian side. As the ice breaks from the west coast of Siberia it has little opportunity to float away because its drift is held by Novaya Zemlya. The west wind has little influence in the east because of the mountains. Therefore the eastern side is colder than the western side. Cold winds blow eastward from the western valleys and cold air flows, as an east wind, over the ice-covered Kara Sea. Novaya Zemlya, ice

free for four months, is fog bound nineteen days of every month. In 1931 a meteorological station was built at Cape Desire, the northern point of Novaya Zemlya.

Vegetation

The scanty vegetation grows principally on the southern island. The 150 flowering plants found in the south far outnumber those in the north, but mosses and lichens are patchy in both sections. A green foreland extends along the west coast. Lichen growth is thin with an occasional poppy. Saxifrages and grasses grow where the talus has been more weathered. Moss grows on clay soil with polygonal cracks. Limestone soil and bird droppings give richer vegetation. Richer and denser growth occurs at the bases of mountains and in depressions. Crowfoot, Jacob's ladder, purple saxifrage, Arctic poppies, and a rare grass flourish.

Animals

In Novaya Zemlya sea animals are more numerous than those of the land. Both seas abound with mammals especially the seal and white whale, crabs, and fish. The wealth of fish in the surrounding waters attracts many fishermen. Inland waters contain salmon. Along the coast and inland are the polar bear, Arctic fox, lemming, and reindeer.

Birds, such as the guillmot, auk, petrel, and sea gull are more numerous on the Barents Sea side because of plentiful sea food. The lowlands have ptarmigans, snowy owls, snow buntings, hawks, geese, and ducks in great numbers.

Inhabitants

Yearly visits to Novaya Zemlya are made by the Samoyed and Russian hunters. Reindeer are taken for their furs. On the west coast there are four permanent Samoyed settlements. Their total polulation is about 100.

Minerals

Mining of anthracite is carried on in a very small way in Novaya Zemlya. Copper is found on the islands.

North Land

North Land, situated at 80 degrees N latitude and 100 degrees E longitude consists of three large main islands and two small islands. Taimyr and Komsomolskoi Pravdy Islands lie east of Cape Chelyuskin while North Land proper lies north of the cape. Cliffs 1,640 feet high, with glaciers between them, lie along the east coast of North Land. These cliffs are a continuation of the Byrranga Ridge. This group of islands borders Kara Sea and is one of the causes for its heavy ice condition.

In temperature, North Land resembles the American Arctic Archipelago. Its July temperature is below 36 degrees Fahrenheit. From September to May its shores are icy because of the influence of the Kara Sea.

A station was begun in North Land (in 1930) for the purpose of studying and mapping the archipelago.

Lemming, reindeer, polar bears, and birds are the animal dwellers on this group of islands.

New Siberian Islands

Topography

The New Siberian Archipelago in the Laptev Sea consists of four main islands and many smaller ones. Kotelny Island, in the west, is the largest and the highest. Mt. Malakatyn, on this island, has an elevation of 1,140 feet. The central area of the island is a plateau. A faulted condition permits a rive to flow across the island toward the northwest. Novaya Sibir, with an elevation of 330 feet, is the easternmost island. Its folded structure contains bituminous coal seams. Ice masses are present. A large valley lies between the two fault limes. Between Kotelny and Novaya Sibir Islands lies Faddeevski Island. Great Lyakhovskie Island to the south of these three has a slight elevation. This archipelago is related to the Verkhoyansk Ark for the mountains are partly worn by ice. An eighty foot thickness of frozen silts and sands of the Pleistocene Age are resting on the ice mass which is sometimes called Arctic Stone. This ice illustrates the cause and natural conditions of the Ice Age. Toll[76] said the ice was of fossil character and it may be a relic of the last glacial period. It exists almost wholly in river valleys particularly on Lyakhovskie Island. Bunge Land, between Kotelny and Faddeevski, is a very low sandy area. In summer it shifts back and forth about one and one-fourth miles.

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76. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

The New Siberian Islands are an ice free area with permanently frozen ground below a layer of earth. Soil is a gray brown color.

The July temperature is below 36 degrees Fahrenheit. In this respect these islands also compare with the American Arctic Archipelago.

Vegetation

Vegetation of the New Siberian Islands is very poor in species and growth. Kotelny has 36 flowering plants. Dry tundra exists and, where it is extremely dry, it is stony. The well watered valleys have green grass. Fossils of large sized alders and birches have been located.

Animals

The New Siberian Islands are important for their deposits of fossilized mammoths which are visited by collectors. Other fossils are of the rhinoceros, horse, deer, antelope, tiger, and elephant.

De Long, Wrangel, and Herald Islands

De Long Islands are on the continental shelf northeast of the New Siberian Islands. Bennett Island, with its rocky, snow-covered plateau, is the largest. There are a number of glaciers. Small Henrietta Island, to the east, lies under an ice cap with an elevation of 3,280 feet. Other islands in the group are Zhokhov, Jeanette, and Vilkitski. There is scant tundra growth in the valleys. Mammoth remains have been found. Birds breed on the cliffs.

Wrangel Island has three mountain ranges lying in a west to east direction. Tundra is scant. Mammoth tusks are found. Russia claims ownership of this island.

Small Herald Island lies east of Wrangel Island. It has an elevation of 1,150 to 1,300 feet. The flora is scant but it is visited by birds.

The Antarctic Region

Explorations

Most of the explorations of Antarctica have been made by the peoples of Western civilization from the Northern Hemisphere. The aim of Antarctic exploration has been scientific search for knowledge even though this knowledge is not so detailed or uniform.

The South Georgia Islands were discovered by Amerigo Vespucci in 1501-1502.

Magellan, in 1520, believed Tierra del Fuego to the the Antarctic Continent.

Bouvet[77] discovered Bouvet Island in 1739.

In 1772 Marion and Crozet Islands were discovered by Marion and Dufresne.[78] In the same year Kerguelen and Tremarec[79] discovered Kerguelen Island. Between 1772-1775 James Cook's[80] purpose was to search for the continent of Antarctica. He succeeded in discovering the South Sandwich Islands.

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77. - 80. THE POLAR REGIONS, R. N. Rudmose Brown.

With Russian sponsorship, between 1819-1821, F. G. Bellinghausen[81] discovered Peter I Island and Alexander I Land (Island). The British sealers, W. Smith and G. Powell[82] discovered the South Shetland Islands in 1819 and the South Orkney Islands in 1821. E. Bransfield[83] first sighted the Antarctic Continent in 1820 but it was discovered a year later, 1821, by the Connecticut Yankee, Nathaniel Brown Palmer.[84] The whaler, James Weddell,[85] founded the Weddell Sea in 1823-1824 and reached 74 degrees 15 minutes S latitude. East Antarctica was founded by whalers Biscoe, Kemp, and Balleny.[86] John Biscoe[87] discovered Enderby Land in 1831. John Balleny,[88] in 1839, discovered the volcanic Balleny Islands.

Longer stretches of the Antarctic coast were discovered by James C. Ross, Charles Wilkes, and Dumont d'Urville[89] between 1838-1843. They discovered the West Antarctic Peninsula, the coast of South Victoria Land, the Ross Sea Ice Barrier, and the unconnected landfalls in East Antarctica from Cape Adare to Knox Land. Charles Wilkes,[90] in 1840, traced the edge of the ice to the west and reported several high lands. Wilkes' expedition was the first and only expedition in the Antarctic before Byrd's. From an airplane Byrd thought Graham Land was an archipelago. Dumont d'Urville[91] discovered Adelie Land in 1840. Sir J. C. Ross,[92] in 1841, discovered South Victoria

81. - 83. THE POLAR REGIONS, R. N. Rudmose Brown.
84. GEOGRAPHICAL REVIEW, October 1940.
85. Ibid, ff. 83.
86. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.
87. & 88. Ibid, ff. 83.
89. Ibid, ff. 86.
90. - 92. Ibid, ff. 83.

Land, the two great Antarctic volcanoes, Erebus and Terror, and the ice barrier at the head of Ross Sea. In 1843, he reached Weddell Sea and reported a depth of 4,000 fathoms. To Ross we owe the conception of "The ice-covered land with its terrible storms, the high coastal walls with their mighty glaciers, the great volcanoes with their smoke banners high up in the snow-swirling air, and, not least, the ice wall that bears his name."*

Captain E. Dallman,[93] in 1874, discovered Bismark Strait and areas in the Graham Land region. Captain C. A. Larsen[94] discovered Oscar and Foyn Lands. Captain L. Kustensen and C. E. Borchgrevinck[95] found Possession Island and Cape Adare in the Ross Sea in 1895 and made the first landing on the Antarctic Continent. In 1898, Belgium made biological collections and a series of meteorological observations on the western side of Graham Land.

The greatest advances on the Antarctic Continent were made in the twentieth century under the recommendation of the International Congress at Berlin in 1899.[96] "The Belgica" wintered off the peninsula of West Antarctica while extensive coastal surveys were made. This expedition discovered new lands. Scott crossed the high coastal range and advanced on the inland ice cap. The eastern side of West Antarctica was thoroughly explored and Coats Land was discovered. In the

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* THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.
93. - 95. THE POLAR REGIONS, R. N. Rudmose Brown.
96. Ibid *.

"Gauss" under Erich von Drygalski[97] an approach was made to the Antarctic Continent by way of the Indian Ocean quadrant. Kaiser Wilhelm II Land was discovered and records of observations were made at this time thus giving a clearer conception of the Antarctic Continent. Several vessels of the International Geographical Congress at Berlin were carried north by the current. In 1900 Borchgrevinck[98] wintered at Cape Adare in Antarctica.

The English started a series of expeditions with Captain R. F. Scott in 1901-1904.[99] Next came the Germans in 1902 under von Drygalski. Drygalski was the first to set foot on the mainland of the northern coast of East Antarctica. Under Nordenskjold,[100] the Swedish expedition of 1902-1903, made the earliest geological research on the east side of Graham Land. The Scotch, under Bruce,[101] discovered Coats Land in 1902. The French, under Charcot,[102] 1903-1905, explored the west of the peninsula of West Antarctica.

Ernest H. Shackleton[103] in 1908-1909 made an attempt to reach the South Pole by following the coastal range of South Victoria Land to the south. He achieved the discovery of the South Magnetic Pole placing it at 72 degrees 25 minutes S latitude and 155 degrees 16 minutes E longitude. It is believed that the actual magnetic pole moves. In Shackleton's attempt to locate the pole he used ponies and automobiles.

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97. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.
98. - 102. THE POLAR REGIONS, R. N. Rudmose Brown.
103. Ibid, ff. 97.

Between 1911-1914 sledge journeys were made by Sir Douglas Mawson.[104] He was the first to survey longer stretches of the northern part of the East Antarctic coast. On December 14, 1911, Captain Roald Amundsen[105] reached the South Pole by way of the Ross Sea. Scott,[106] reached the South Pole January 17, 1912, thirty-four days later than Amundsen, and died enroute from the pole.

Further explorations were made, in 1929-1930, by Sir Douglas Mawson[107] revealing the coast line of Enderby Land. Mawson, Riiser, and Larsen[108] discovered new land east of Coats Land on the eastern side of Weddell Sea.

The Byrd Antarctic Expedition of 1928-1930[109] accomplished various flights surveying 150,000 square miles by aerial camera. One survey was made from Lindberg Inlet on the Bay of Whales into the shelf ice. Four flights were made northeast and east of Little America. One of these flights was to Hal Flood Bay which had probably been reached before by Prestrud in Amundsen's expedition. A second was taken to Scott Nunatak in Alexandra Mountains which had been seen by Scott in 1902. The third flight was made to King Edward VII Land. The last flight, from the main base, was to the new crescent shaped range, Rockerfeller Mountains. These peaks in the northeast and east bear east. They discovered a plateau south of 81

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104. - 106. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.
105. - 109. THE WORK OF THE BYRD ANTARCTIC EXPEDITION, 1928-1930, W. L. G. Joerg, 1930.

degrees S latitude with an elevation of 1,370 feet. A flight to Marie Byrd Land claimed it for the United States, and Scott Land was named. A refueling station was established at the base of Mt. Nansen for use on the final flight to the pole. The second Byrd Antarctic Expedition proved that Little America and the Ross Barrier Ice were afloat.

Mapping 2,300 square miles of the eastern coast of Graham Land was done, in 1935, by Lincoln Ellsworth[110] on his trans-Antarctic flight. A map was made to show the great linear depression and its bordering upland south of Marguerite Bay for 9,000 square miles. James W. Ellsworth Land was claimed for the United States between 80 degrees and 100 degrees W longitude. Maps were made of Sentinel Range which is isolated in the interior almost midway between the eastern and western edges of West Antarctica. A map was, also, made of the eastern coast of South Graham Land showing the mountainous coastal belt.

During the German Antarctic Expedition of 1938-1939, 11,600 photographs were taken adjacent to Coats Land between meridians 16 degrees E longitude and 9 degrees W of Greenwich.

Reports indicate that Admiral Richard E. Byrd's expedition of 1946-1947 will reveal much that has not previously been discovered. Some of these reports already make known the discovery of a region of lakes completely devoid of ice inland from Knox Coast, and numerous rock islands above the Shackleton

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110. BEYOND HORIZONS, Lincoln Ellsworth.

Shelf Ice on the Queen Mary Coast.

Great Britain has taken possession of the greater part of the Antarctic Continent. Under the title Falkland Dependency, she claims the whole of Weddell Sea and the West Antarctic sector to the South Pole. Ross Sea Dependency includes South Victoria Land and the Ross Sea.

The Antarctic Continent

Topography

The Antarctic Continent is in no way attached to the main land masses of the Southern Hemisphere. The nearest land is five hundred miles away. The size of Antarctica is believed to be larger than Australia, or one and one-half that of Europe, or a little less than North American including Canada and the United States. In area it is about five million square miles.

The high plateau interior is the greatest desert on earth. The altitude of 7,000 feet is greater than that of any other continent due to its ice cap. The ice cap of Antarctica covers the entire area of the continent and, in places, flows beyond the edges into the sea. It is the only continent made in a single mold. The underlying rock doesn't show. The material underlying the ice and glaciers would make an interesting field of research. The inland ice ends in border walls, shelves, and tongues which eventually crack off or calve to make icebergs. The continent is divided into East and West Antarctica. Then it may again be divided in Quadrants, the

Atlantic, Indian, Australian, and Pacific. The predominating structure of East Antarctica is of the Indo-African plateau type while the outstanding structure of West Antarctica is of the American Pacific folded type. Both are joined under the ice. Ice in Antarctica makes little sound. The coast gives a variety of form.

The continent is mostly flat with occasional mountains rising 6,500 to 10,000 feet. Mountain sections, with their exposed rocks, are the most free of ice. Monotony of the terrible expanse of endless white is nerve wracking. The hard snow surface eases landing and take off of airplanes. The surface shows a variety of conditions - crevasses, undulations, soft spots, and sasturgi. Where the ice sheet meets open water and high wind there are crevassed areas and sasturgi, a heavy, hard, rough surface of long parallel ridges not much more than three inches high.

The compact uniform shape of the continent of Antarctica is surrounded by an ocean of ice and scattered islands. The only indentations are the Ross Sea and Weddell Sea which serve as the two approaches to the continent.

The ice belt of the Antarctic Continent is five to six hundred miles wide and begins at or near 66 degrees S latitude. Icebergs are found at 63 degrees S latitude and become more plentiful nearer the continent for the ice is more dense. In the tidal zone is a narrow ledge of sea ice called ice foot. The east-west stretches are covered with deeper ice which makes

sailing difficult.

The waters surrounding the Antarctic Continent contrast with those of the Arctic because they are strewn with great icebergs calved from the enormous ice cap. Shelf ice, the projected inland ice, develops in the sea and grows in size, because of the new snow on floe ice. Shelf ice bears evidence of great age which is shown by its polished, rounded surface. The continental shelf is shaped and dominated by shelf ice. Sea water adjoining the ice almost freezes. Drift ice, in the form of icebergs and floes, is more evident in the Antarctic than in the Arctic. Floe type icebergs are formed by the freezing of water and the accumulation of snow. This type floe melts on the undersurface. The melt water type floes are formed by the freezing of melt water lakes on the ice fields. Destruction of drift ice is due to wave action.

The densest ice pack is broken by narrow leads around which ships can be forced or eased. Pack ice is more brittle than floe ice. The presence of killer whales is a sign of open water.

Currents are easterly near the continent and westerly farther out to correspond with the winds. Ross and Weddell Seas have clockwise currents. A current from the southern latitude with a depth of 5,480 feet was discovered by Baron Humboldt in 1802. A South Atlantic Current is present near the Cape of Good Hope. Ross ascertained that, between 55 degrees S latitude and 58 degrees 31 minutes S latitude, the sea encircling the earth had a mean temperature of 39.5 degrees

Fahrenheit. If one were interested in oceans, the study of the origin and movement of polar water, the origin of cold bottom water, ocean bottom deposits, tides, and shelf ice would make a fascinating problem to solve.

The southern part of Weddell Sea is covered by the Filchner Shelf Ice. In front of the shelf ice is a shallow sea 1,960 to 2,300 feet deep, Deep parts of Weddell Sea are 13,000 to 16,500 feet and, east of the South Sandwich Islands, the depth goes to 26,000 feet. Weddell Sea has many different temperatures and layers of water. On the surface there is a tendency to a rotary current. An unfavorable ice condition is present in the sea because the wind pushes the ice toward the West Antarctic Peninsula. True pack ice is present in the western part of Weddell Sea as a result. It is unusual for the Weddell Sea to be open in the Antarctic spring.

In February the Weddell Sea becomes ice free allowing the west side to be accessible. Permanent drift ice lies on the eastern side because the current flows south on the eastern side and north on the western side. An ice wall extends across the Ross Sea from Ross Island to King Edward VII Land. This barrier is formed by the growth of long ice tongues from Beardmore and Axel Heiberg Glaciers of Victoria and Carmen Lands. Beardmore Glacier is situated at 85 degrees S latitude. The Ross Barrier is 465 miles long and 435 miles wide, about 1,000 to 1,300 feet deep, and 100 to 150 feet above sea level. The second Byrd Antarctic Expedition recorded an ice thickness of 500 feet. It progresses north about 1,650 feet per year.

On Byrd's return Little America had become a potential iceberg. The northern part floats on the water and moves with the tides. Behind the East and West Capes, the Ross Barrier ice is grounded. Ridges, reefs, and skerries are present 200 feet below sea level accounting for the Bay of Whales as a fixed structure. Roosevelt Island, 100 miles long and 50 miles wide, lies south of Little America. The ice barrier is a vast plain with varying surface areas of high drifts, snow pillars, regular waves, a snow cover which may be soft, crusty, or blown into hard ridges, and crevasses where it approaches land. The eastern part of the barrier has an embayment, called the Bay of Whales, where animal life is centered. Dazzling white icebergs are calved from the Ross Ice Barrier. Ice at the barrier disintegrates by dissolving within a period of ten seconds without any noise. When a slab of barrier ice calves it makes a vast, confused sound like the roar of a waterfall which lasts only a few seconds.

Belief exists that a strait divides the Antarctic Continent. This has been suggested because of the geological and structural dissimilarity between the opposite regions of the continent are favorable for a strait. The Ross and Weddell Seas are on the opposite sides of the continent and are further evidence of a strait. The behavior of tides in the Ross Sea indicate that a possible strait exists. The high ice covered land southeast of the Bay of Whales and the low, level ice cover, over one hundred miles in length, at about 82 degrees

S latitude (according to Amundsen's report)[111] also suggest a possible strait. Similar indications are evidenced by the calm air at the edge of the Ross Ice Barrier.

Findings in moraines, erratics, roches moutonees, dead ice of the valleys and coastal walls show that once glaciation was greater than it is today. The coastal walls of South Victoria Land, off the coast of Gaussberg, in the Ross Sea, Luitpold Land, King Oscar Land, and lastly in the low lying continental shelf at 1,000 to 2,300 feet prove a period of greater glaciation. Glaciation today takes the form of continental inland ice which moves toward the periphery at the rate of 500 feet per year forming the shelf ice barrier in the Ross and Weddell Seas. Today ice recession continues. In the vicinity of Rea Mountain, an ice recession of 200 feet is estimated.

West Antarctica is a continuation of South America, related to the Andes Mountains because of its folded structure paralleling the coast. The valleys and coastal outline run parallel to the folds and make a fiord-like coast. The peninsula's ice-covered mountain range has crests with altitudes over 6,500 feet. Altitude of the peninsula decreases toward the north. Even though some of the tapering projections of the West Antarctic Peninsula have topographical features not marked in the ice cap, the northwestern coast of Graham Land is completely ice-covered. Islands which rise steeply from the sea are free from ice. Glaciation is at its maximum in the western belt of the peninsula. The steep peaks are blanketed and coastal ice forms great foreland glaciers.

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111. DISCOVERY, Richard E. Byrd.

comparable to those of Spitsbergen. The snowline of Palmer Archipelago is at sea level. Small islands are ice-domed and only the highest elevations protrude. Icebergs float around by the hundreds. The eastern coast of South Graham Land has mountains with rocks which are cut through by valley glaciers dividing it into numerous capes and headlands. Some of these extend to the shelf ice on Weddell Sea and others are fronted by an apron of piedmont ice. Otto Nordenskjold[112] found the fine glacial mud, loess, carried and deposited by the wind. The east coast is divided into two segments. The northern part is concave toward the sea and the southern part is rectilinear and extends north and south.

At the end of the West Antarctic Peninsula is Louis Philippe Land; on the east, King Oscar Land; to the west are Danco, Graham, Loubet, Fallieres, and Charcot Lands. Farther west is Peter I Island. To the north are Adelaide, Biscoe, and Palmer Archipelagos. Deception Island, which lies north of Bransfield Trough, has fumerols and hot springs which tell of recent activity. The South Shetland Islands continue east northeast by a series of sub-Antarctic Islands. On the Weddell Sea side are Joinville and James Ross Islands. James Ross Island, with Mt. Haddington, seems to have been a great bedded volcano.

Eternity Range rises to an elevation of 11,000 feet and lies to the south of Stefansson Inlet. It is a direct

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112. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

continuation of the main axis of Graham Land and is made up of sub-ranges. Its eastern border seems to form the western coast of Weddell Sea. Alexander Land lies on the western side of Stefansson Strait.

Inland on the Antarctic Continent is Sentinel Range. It consists of a main range with a number of sub-ranges and outliers. Beyond this range, to the west, lies James W. Ellsworth Land. Westward is Marie Byrd Land, an area of high elevation. A matterhorn of 5,000 feet is isolated on its western border. The mountain chain connected with the matterhorn lies at a distance of seventy miles and has an elevation of 5,000 feet. The serrated ridge of smaller peaks bears no name. Rockerfeller Mountains have a crescent shape with forty peaks and ridges struggling to keep their heads above the snow. Fourteen peaks have bare rock patches. The lowest peak has an elevation of 500 feet and the highest has an elevation of 2,075 feet. Specimens from the mountains show granites. The ice surface about the Rockerfeller Mountains is from 300 to 400 feet above sea level. The range is bare on the northern side due to the strong northerly winds. On Gould's[113] trip a new land was located south in Marie Byrd Land. A crevassed area extends west from the Rockerfeller Range to the Bay of Whales. Scott Land is located between 80 degrees 30 minutes S latitude and King Edward VII Land. King Edward VII Land is a number of islands welded together by ice and located on the eastern side

113. THE WORK OF THE BYRD ANTARCTIC EXPEDITION OF 1928-1930
W. L. G. Jeorg.

of Ross Sea. Amundsen collected rock specimens from the little sections that were snow free but most of this land is deeply buried in ice.

Queen Maud Range lies south of the Ross Barrier and has low shelf ice extending southward along the outside of the range. Crevassing, in the shelf ice along this range is on a gigantic scale. Carmen Land area, incompletely mapped by Amundsen, was claimed for the United States.

Victoria Land is a narrow mountainous belt parallel to the coast and lying between 160 degrees and 170 degrees E longitude. The northern part has an elevation of 9,000 feet and its highest peak, in the vicinity of the South Pole, reaches 16,000 feet. Victoria Land is a volcano-studded fault margin of the plateau. The western slope of this mountain area descends gradually to join the plateau ice. The east slopes abruptly to the Ross Sea. Recent volcanic islands are in front of the coast. Faults in the mountain belt show that it contains coal seams. Back of the coastal wall are high mountains and ranges. Admiralty Range lies to the north, Prince Albert Mountains are north of McMurdo Sound, and Royal Society Range is south of McMurdo Sound. Queen Alexandra Range lies to the south of the Ross Shelf ice and west of Beardmore Glacier. Queen Maud Range lies to the east and beyond. Massive Mt. Nansen lies in back of Terra Nova Bay and is heavily and deeply crevassed. This mountain was ascended to an elevation of 6,500 feet. Because Beacon sandstone was found, it is believed that coal lied under the South Polar Plateau and back of the horst for

some 100,000 square miles. Conrad Range is south of Moore Bay. Britannia Range lies between the Great Barne Glacier and a northern neighbor.

Volcanic mountains included in Victoria Land are Balleny Island, in the vicinity of Cape Adare; Coulman Island; Mt. Melbourne; Ross Island, with its four cones and its neighbors; and Mt. Discovery, on a projection from the mainland. McMurdo Sound, enclosed between Ross Island, the mainland, and the Ross Shelf Ice offers tempting opportunities for scientific research because of the still active Mt. Erebus. In the vicinity of McMurdo Sound there are lakes frozen to the bottom which do not thaw for years.

Samples of soils taken from Victoria Land were proved to be alkaline. Tests showed an accumulation of salts, carbonates, and zeolites. Organic acids are absent. Plants can grow in such soil.

Liv Glacier lies before the South Polar Plateau. It is steep and badly crevassed. South of Liv Glacier is the South Polar Plateau, 10,000 feet above sea level, and ranging in altitude from 7,000 to 11,000 feet. This great plateau descends to the coast in all directions. The inland ice of the South Polar Plateau is underlain by a rock structure which shows on the moraines of the marginal regions. This ice plateau ends in marginal mountains on the west and south borders of the Ross Sea. Crevasses, clefts, and occasional small moraines are found in the marginal zone. The highest point (10,000 feet) lies in the vicinity of the South Pole.

Alterations in the plateau surface are soft snow plains, a firm thin snow crust, level areas, hard snow ridges, and haycocks which are rounded domes of snow covering bottomless pits. The movement of plateau ice varies from 325 to 1,650 feet per year. The South Polar Plateau is fringed with peaks 15,000 feet in altitude. A new range of mountains extending north and south lies on the west of the plateau from Liv Glacier.

The lands of East Antarctica face the Indian and South Atlantic Oceans. Admiralty Range parallels the northern coast for a stretch. East Antarctica includes Oates Coast, King George V Coast, Adelie Coast, Wilkes Land, Knox Coast, Queen Mary Coast, Wilhelm II Coast (upon which is Gaussberg volcano with an elevation of 1,200 feet), Kemp Coast, Enderby Land, and Coats Land. The coastal shelf is narrow with an outer edge sometimes higher than an inner edge. Great bodies of shelf ice lie in several places. The inland ice slopes down in ice cascades from elevations 3,280 feet high in the last two or three miles journey to the sea. It finally ends in an abrupt cliff 130 to 160 feet high. Coastal rocks are in the form of nunataks or off-shore islands. The north coast of East Antarctica receives warmer water from the Indian Ocean by way of the Kerguelen Trough.

Coats Land, with Caird and Leopold Coasts, are located on the east coast of Weddell Sea. Inland ice ends here in great broken and crevassed ice cliffs. Leopold Coast is an ice shelf which rests on the plateau that underlies the Weddell Sea in this area.

Climate

A greater climatic severity is present in Antarctica than in the Arctic because it is more remote from other land masses. The Antarctic Continent has a continental climate with cold, short summers, bitterly cold winters, and violent snowstorms. There is very little thaw except where the volcanic sand and dust fall. No sound of rushing torrents can be heard. Wind, temperature, and current conditions have a more latitudinal arrangement. There are marked changes in climate within a few degrees of latitude.

"This phenomena, the splitting up of the ice belt might occur within an hour, and again it might be days before it happened."*

Low pressure areas decrease toward the Antarctic Circle. High pressure areas increase going to the edge of the ice pack. Because of the pressure and winds, it is believed that the Antarctic Continent is covered by an anticyclone. High atmospheric pressures are common in winter.

> "The beauty of the cold of winter was the clarity of the night and the great joy of skiing. Never were the stars brighter than when the temperatures were sagging through the 50's and 60's. We could see and hear for miles. The sky was chockful of stars and if the moon was full we could bearly make out the white bluff of West Cape."**

There are greater barometric changes in Antarctica than anywhere else on earth. In order to fly successfully in

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* BEYOND THE BARRIER WITH BYRD, Lt. Harry Adams, p. 119.
** DISCOVERY, Admiral Richard E. Byrd, P. 200.

Antarctica it is necessary to have bright weather.

> "At certain hours and under certain conditions the beautiful prismatic effects of the sun's rays, the translucent atmosphere, and the pure white snow combine to create and diffuse the most dazzling color schemes imaginable. If an artist were to transfer some of the midnight effects, the amber, and pink, and purple with the golden ribbons of the sun to a canvas, the popular criticism would condemn the painting as being untrue to Nature. Yet the Antarctic could sustain the artist should he use the most dazzling shades and tints of color. At times, off to the south, the barrier changes to a pale and delicate pink, so transparent that the imagination seems to see far into the depth of that solid mass of ice. More distant icebergs, clouded at their bases, but with high lights and deep shadows in parts above, often appear as islands green with verdure and dark with valleys. Occasionally some vagrant ray of light will create a broad river across this mirage of pastoral beauty, only to disappear as suddenly as it came, leaving nothing but a huge mass of ice both grim and awesome."*

On Byrd's flight to the South Pole the dog team trail could be seen from the air only with the sun in a certain position.

> "Great white glaciers flowed into the Barrier and about one hundred miles off were some alpine snow-covered peaks towering high over the Barrier that glistened like fire from the sun's reflection so that they looked like great volcanoes in eruption."**

The Aurora Australis can be seen on ninety per cent of the clear nights. In the Ross Sea and on the Ross Shelf Ice atmospheric depression is deflected southward. The pressure is lower on the ice wall than in Victoria Land therefore, the area is unstable. On the shelf ice the pressure increases toward the south, wind velocity is less, calms are frequent, the

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* BEYOND THE BARRIER WITH BYRD, Lt. Harry Adams, p. 174.
** THE WORK OF THE BYRD ANTARCTIC EXPEDITION, 1928-1930, W. L. G. Joerg, p. 38.

average temperature is lower than that of McMurdo Sound, and the yearly variability is great because of a steep temperature gradient between the ice shelf and the water front.

Experiments made by kites and balloons show that the study of the upper air movements aids weather prediction. Upper air currents feeding anticyclones are opposed in direction to the surface currents. Evidence of this movement is shown by experimental balloons, clouds, and smoke from Mt. Erebus.

Low pressure occurences lessen the wind in Antarctica. Winds of the Antarctic Continent are stronger than those of Arctic regions. Winds in Antarctica have an average velocity of fifty miles per hour. Violent winds rage from seventy to eighty miles per hour. The local conformation is believed to change the direction of the winds. Prevailing southerly or southeasterly winds are present beyond the Antarctic Circle and on the continent. The ocean and air currents correspond and are easterly near the continent. East winds determine the warmth for the margin of the continent. Easterly winds blow parallel to the coast and are parts of the rotational motion about the low pressure areas which sweep through the depressional trough lying in front of the continent. The west winds blow north of this trough. Constancy of the east winds is caused by the cold stratum of air on the continental margin flowing outward and acting as a regulating wall. The east winds drift snow and blow it away.

The exposed rock in mountain sections is denuded as a result of summer insolation, frost weathering, and strong winds.

"The violent wind acts as a formative agency on rock and snow surfaces. It transports snow, dust, and sand; it creates small heaps of coarse detrital material like those of stony deserts; it polishes boulders and bed rock; it furrows the snow and shapes it into sharp-edged sasturgi."*

Explorers have decided that the area where the surface of the South Polar Plateau has haycocks must have been caused by violent winds.

Individual storms are more intensive than in the Arctic. The change to calm is often abrupt. Heavy drift in Antarctica is termed blizzard when the air is filled with thick snow.

"In heavy blows you can't see a foot ahead; the particles of drift hit the eyes in heavy flight, hot and stabbing as sand."**

There are five weeks of heavy blizzard, and one hundred twelve days of light blizzard. Probably blizzards are caused by air flow down slopes from higher areas on the plateau. Wind, during a blizzard, is generally from the south. One explanation of the blizzard near the Ross Sea is that the higher atmosphere slide over a calm layer of dense cold air and causes an eddying motion that churns both together till it forces the wind of the higher atmosphere to the surface. The temperature always rises during a blizzard.

"It is also true that the ordinary person, who can see little or no worth in polar expeditions, at least an investigation of weather seems to possess some practical merit. Recent years have witnessed a widening interest in polar meteorology especially that of the south polar

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* THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking, p. 287.

** DISCOVERY, Admiral Richard E. Byrd, p. 196.

regions; and as a consequence of the activities of various expeditions more people are beginning to realize that the great polar ice caps play a dominant-perhaps even a predominant-role in maintaining the broad circulation and movements of air on which depend the climates of the world, and with them all human activities."*

Gould's [114] group based near the Rockerfeller Mountains, met with weather that threatened to destroy their plane.

"With early morning the wind was on the increase. Our tent was snapping and cracking - sounded like a broadside of muskets. One cannot imagine the din inside even a small tent in such a gale. He must experience it."**

The southerly winds in the Ross Sea sector are of great strength. At McMurdo Sound the wind velocity is greater in the winter than in the summer. The opposite is true at Cape Adare for it has a stronger wind velocity in summer than in the winter.

The northern coast of East Antarctica has violent air movements. For weeks the wind varies from storm to hurricane often accompanied by severe blizzards. The disappearance of snow on the northern coast of East Antarctica is brought about by the wind rather than by melting. The winds create a special ice called blue ice. It is a region of violent gales and winds of hurricane velocity. Optical illusions are caused by low visibility.

"The wind tossed coastal water froze into fantastic forms-a frothy sea of ice. Farther out, however, the sea was kept free of ice by the wind, even in winter. The southern sides of rocks were scoured smooth, the lee sides were rough. Not infrequently objects weighing hundreds

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* BEYOND THE BARRIER WITH BYRD, Lt. Harry Adams, p. 153.
114. THE WORK OF THE BYRD ANTARCTIC EXPEDITION, 1928-1930, W. L. G. Joerg.
** Ibid, p. 23.

of pounds and the men themselves were swept through the air for yards. Walking was possible only with crampons and not vertically but only by holding the upper part of the body nearly horizontal in the teeth of the wind. In every respect life had to be adapted to the force of the wind."*

In Coats Land, Caird Coast and Leopold Coast the winds are on the eastern side of Weddell Sea. Blue icebergs are calved from this area. On Weddell Sea and Filchner Shelf Ice, the wind makes the air temperature colder than that of the water. The wind pushes the ice ahead into the South Atlantic Ocean but the West Antarctic Peninsula stands in the way and acts as a breakwater. There is a great deal of clear weather and temperature inversion is large. Snow Hill in Graham Land at 64 degrees S latitude has prevailing south to south southeast winds.

The cooling power of the atmosphere is brought about by varying conditions. Laurence M. Gould, the geologist along on the Byrd Antarctic Expedition of 1928-1930 states:

"The driving snow in the teeth of the awful wind was worse than needles. My beard and face became encrusted and I lost all sensation. I thought it and my wrists had been frozen. I had to blink vigorously and continuously to keep my eyelids from freezing shut."**

Summer days and winter nights are each six months in length.

The Antarctic Continent acts as a reservoir of cold because the summer insolation melts little ice and snow and the

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* THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking, p. 310.

** THE WORK OF THE BYRD ANTARCTIC EXPEDITION, 1928-1930, W. L. G. Jeorg, p. 22.

southerly surface air currents are so cold. Summer cold is a striking feature for summer temperatures here are the coldest known on earth. The highest temperatures are in December and January and, even during these months, the mean temperature is practically always below freezing. Cape Adare has its warmest month mean of 31.6 degrees Fahrenheit; McMurdo Sound 24.9 degrees Fahrenheit; the Ross Shelf edge, 19.9 degrees Fahrenheit; and Little America 21 degrees Fahrenheit on the coast. Summer temperatures are below 32 degrees Fahrenheit and Amundsen recorded summer temperature as between 19 and 20 degrees Fahrenheit. Members of Byrd's Expedition found Amundsen's cairn intact after eighteen years.

Insolation is needed to raise the polar temperature in the summer. The mean temperature of the atmosphere within the Antarctic Circle in summer is 27.3 degrees Fahrenheit. Insolation is held in check by the glaciers, ice-fields, and pack ice. Glacial ice is also due to the cold summer. Owen[115] used the highest black bulb thermometer to measure the amount of heat radiation by the sun. A temperature of 115 degrees Fahrenheit was recorded but did not represent the actual outside temperature. According to temperature records, the sub-surface temperature rises at the height of summer. The sun's insulation during the summer does have effect on dry snow.

> "The sun's rays actually penetrate the snow to some depth. The heat obtained from the sun was indicated by the way in which dark objects sank in the snow - a

115. Ibid.

tarpaulin fifteen feet square sank nine inches in two sunny days."*

Solar radiation is intense enough to cause a severe sunburn.

While Gould was on an expedition to Rockerfeller Mountains, the temperature range was from 14 to 17 degrees Fahrenheit. In the summer considerable snow melts from the peaks that have large rock masses. A short distance from the mountains, the snow sometimes thaws into a slushy mass. In warmer months ponds of water form. No evidence of glaciation is present on the mountains but, to the east of Rockerfeller Mountains, where the plateau is crevassed, the movement of snow and ice over the land shows.

Very cold autumns precede an early winter. Winter temperatures of the whole continent have never been studied. High winter temperature was recorded at Snow Hill in Graham Land. The recorded winter temperature for Cape Adare, in Victoria Land, is -14.5 degrees Fahrenheit, McMurdo Sound -14.6 degrees Fahrenheit, and Ross Shelf edge -48.6 degrees Fahrenheit. The absolute minima recorded is -73 and -77 degrees Fahrenheit. The mean temperature of Antarctica is probably below 32 degrees Fahrenheit. Calms bring the lowest temperatures. Low temperatures are no great obstacle to flight.

November is a transition period which brings constant cloudiness. Snow blindness to the man of Byrd's expedition

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* THE WORK OF THE BYRD ANTARCTIC EXPEDITION, 1928-1930, W. L. G. Joerg, p. 68.

seemed worse on cloudy days.

> "One of the reasons for constant cloudiness is that the temperature on the ice cap in the interior, benefiting by the southward swing of the sun, is going up and up, gradually overcoming the tremendous differential that exists between high and low latitudes during the winter months. Temperature gradients give rise to wind: and as the temperatures in these regions tend to equalize over large areas there is less wind, less robust inpourings and outpourings that clear the skies. The prevailing summer winds are light northerly and easterly winds, warm winds which bring fog and cloudiness."*

Temperature inversion is increased by the elevation. The Ross Sea is warmer when a south wind blows moderately, for it sweeps away the cold ground air. On the South Polar Plateau the temperature is mostly one of intense cold. It is believed to be the coldest spot on earth with a mean annual temperature for the South Pole at -22 to -31 degrees Fahrenheit. The mean annual temperature recorded by Mawson is -17 degrees Fahrenheit. On the coast of East Antarctica, the temperature is more stable and uniform.

The conductivity of the snow measured has been by determining the densities of the barrier at different depths, and by taking the sub-surface temperatures of the snow. Findings show that the bottom of a crevass is warmer than the surface. It is -18 degrees at the bottom as compared with -50 degrees at the top.

Ample precipitation accompanies the east winds. Precipitation is more frequent in the summer therefore, the snow cover increases. Most of the snow is very fine and dry. Dry snow is

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* THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking, p. 285.

as fine as flour. Sometimes the snowfall is soft and wet and melts wherever it touches anything. Hobbs[116] believes that some of the moisture in Antarctica is precipitated as hoar frost. Rain is rare in East Antarctica but is more frequent on the western side of the West Antarctic Peninsula. Evaporation is usually less than the meager precipitation of about ten inches. Low evaporation and low specific humidity permit the formation of Antarctica's ice field. Since there are numerous icebergs, it is certain that considerable precipitation is necessary, when there is no snow colors are brilliant and pure in both the sky and the ice.

Fog is sometimes dense in the Bay of Whales.

"Heavy sea smoke, black as a Newfoundland Banks fog, lay over the Bay."*

Sea smoke is caused when the rays of the sun are strong enough to penetrate low clouds and reach the layer of cold air at the sea surface.

The dust content of the atmosphere is one half that of the Pacific Ocean. A study could be made of the remarkable purity of the air.

The climate of the Antarctic Continent is more constant because it is a seagirt land. The southern ocean climate is remarkably uniform since there are no contrasting warm and cold currents. Pack ice extends hundreds of miles off the coast.

"Another of the mysteries of the Antarctic seems akin

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116. Ibid.
* DISCOVERY, Admiral Richard E. Byrd.

to the workings of a magician, for, with a sudden swirl of snow out of a clear sky, and the instant growth of an iceberg coming apparently from nowhere, the observer is left bewildered and amazed."*

The Ross Shelf Ice is largely snow and is therefore a poor conductor of heat. The Ross Sea is open in the summer and partially open most of the winter.

Throughout Victoria Land precipitation is in the form of snow. Half of the time south winds occur in blizzards. Evaporation is great.

On the west and east side of West Antarctica are found contrasting climates. The low pressure area of Belgica and Weddell Seas are separated by the West Antarctic high pressure wedge. Low pressure areas draw air from higher latitudes. These varying pressure areas bring swift changes and irregularities in climate to the West Antarctic Peninsula. Because the warm northeast winds raise the temperature of the west side of the peninsula above freezing, there are less extreme weather conditions. In all months it occasionally rises above freezing. The mild, changeable, maritime climate with its high humidity is accompanied by frequent rain. When the west pressure is high, the east pressure is correspondingly low, and vice versa.

The climate of the Antarctic Continent may determine weather conditions of Australia. Research stations would have to be set up to record atmospheric pressure, air temperature, wind direction and velocity, and blizzards.

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* BEYOND THE BARRIER WITH BYRD, Lt. Harry Adams, p. 119.

Vegetation

The line of woods falls short of the Antarctic Continent and the Antarctic Circle because of the abbreviation of the continents, the unfitness of islands for tree growth, and the climate. Only a narrow border along the coast of Antarctica has plant life and it is scarce in number and variety. Along the impoverished tundra margin are found two flowering plants growing on the very verge of the continent. One is a grass and the other is a tiny pink. Grasses are rarely found south of 62 degrees S latitude. There are sixty species of mosses, one hundred species of lichens, four hundred species of algae colored snow that occurs on damp ground and in sea water. Vegetation is more abundant on the west side of the West Antarctic Peninsula for the rocks are more favorable to plant growth. There are tundras and grassland. East of the peninsula sand and tuffs cannot sustain life. Mosses and lichens grow on the mountain slopes to a thousand foot elevation. There are fifty species of each. Several species of moss grow on the Atlantic Ocean side of Graham Land.

Small snow-free areas on King Edward VII Land are covered with thick moss.

Lichens are found on the rocks of Mt. Nansen. They are also found on a ridge located at 85 degrees 27 minutes S latitude. This is the farthest south that life has been found.

On the northern coast of East Antarctica, where the rock surfaces are exposed to the wind, there is a lack of vegetation and detritus. In protected places, where there is some melt

water, mosses and lichens are abundant.

Sea plant life is divided into two zones, the Antarctic and the sub-Antarctic. All sea life is based upon the diatom which is preserved fresh in the cold water making the water brown because of its abundance. Diatom ooze is common along the ice front.

Animals

Animal life on the Antarctic Continent is limited in number and variety. Large numbers of penguins are found on the ice free surface, seals and whales occupy the waters, and stormy petrels, albatross, and gulls visit the continent.

There are various kinds of penguins. The King Penguin lives north of the Antarctic Circle. The Adelie Penguin dwells along the border of the Antarctic Continent. The Emperor Penguin prefers Victoria Land and East Antarctica. In Mid-winter the Emperor Penguin broods on sea ice. The drift ice of the Ross and Weddell Seas is occupied by these birds. If there were land animals in the Antarctic region the penguins would be destroyed. They have no fear at the sight of men. They inflict wounds by means of their bills and stubby wings. Their neck plumage is valued by furriers. They subsist on a fish diet and, during some of the day, they disappear under the ice to feed.

> "The penguins are perhaps the most abundant and certainly the most curious, for though they resort to the snow-clad ledges of the rocks to breed, they live the lives of fishes. Their short wings are not fitted for flight, but serve as fins to aid them in swimming, while their well oiled feathers form a dense covering as

compact as scales, and not dissimilar in appearance. These birds can swim fast and far under the surface of the sea, and are helpless only on land."*

Sea life near the continent consists mainly of miniature crabs and worm-like fish.

The continental shelf of the Antarctic Continent supports polar sea life. The species of seals and whales are few. Of the seal family, the sea elephant has been almost exterminated by ruthless slaughter. The Ross seal, which lives on the pack ice, has become rare. The most common seal found in the Ross Sea is the Weddell seal. On a stretch of ice three hundred feet long there may be fifty to one hundred of these animals. Other seals are the crab-eater and the sea leopard. Seals dwell on the ice floes in the Weddell Sea. Crab-eater and Weddell seals come to the northern coast of the West Antarctic Peninsula. Seal pups weigh 57 to 85 pounds at birth. Seals in the Antarctic are easy prey. Their only danger on land is man.

There are a number of species of whales in the Ross Sea. The sea is full of finback, blue, and killer whales. The latter have terrible teeth and hunt in packs. They are strong enough to destroy ice almost three feet thick. In 1923-1924 whaling was begun in the Ross Sea and it is the major whaling area today. The Norwegians do the fishing under British control.

The petrels are the first sea birds coming in on the ice of a west wind drift. Mt. Helen Washington of the Edsel Fords

* THE POLAR REGIONS, Sir John Richardson, p. 378.

has snowy petrel rookeries. Birds occupy the ice floes of the Weddell Sea. The gulls are a dirty brown color somewhat like the vultures of India.

Mites and insects are practically unknown. The antarctic zone has a wingless mosquito but no insects in swarms. The rotifer survives in the ice.

The distribution of bird life and both large and small sea life offers another field of study.

No inhabitants occupy the Antarctic Continent. Byrd's Antarctic Expedition of 1928-1930 required the organization of sixty men. Two vessels, four airplanes, and a wireless sending and receiving set were part of their equipment. Their base was established at Little America in the Bay of Whales. The 1946-1947 expedition required the organization of about four thousand men.

Minerals

It is believed there is coal under the ice of the South Polar Plateau. Seven seams of coal have been seen at Beardmore Glacier. The faults in the mountains of Victoria Land also show coal seams.

Copper minerals and Beacon sandstone were found on Mt. Nansen.

Alexander I land yields fossil invertebrates and plants. The research dealing with fossils would be an interesting subject for study. On Byrd's second Antarctic Expedition some valuable tree fossils were obtained from Mt. Weaver.

Sub-Antarctic Islands

Peterman Island, located at the northernmost part of the West Antarctic Peninsula, belongs in the coldest polar vegetation belt. Its scanty vegetation consists of a dicotyl, a grass, sixty-three species of mosses, some lichens, and a rich bacterial flora.

All the islands of the West Antarctic are sub-Antarctic. They are the South Shetlands, South Orkneys, South Sandwich group, and South Georgia group and are located, in a great arc, north of the West Antarctic Peninsula. Because of the oceanic influence these islands have mild winters, a low temperature range, large ice free surfaces, an abundant precipitation, and vegetation.

The South Shetlands consist of three large islands, the Elephant, Clarence, and Deception Islands. Elephant and Clarence Islands are wild and mountainous with sharp peaks and ice. Deception Island is a sunken volcano. It serves as an excellent harbor because the sea has entered its sunken crater. This volcano is not quite extinct because a sulphurous stench and steam rise from the beach. The volcanic gases, steam, and hot springs undermine the snow because of their warmth. Carpets of mosses and lichens serve as covert for insects. Penguin rookeries accomodate 100,000 birds. Because of Deception Island's excellent harbor, it serves as one of the headquarters for the whaling industry of the south polar region.

The South Orkney Islands are located at 61 degrees S

latitude on the northern side of the trough. The South Orkney's consist of two main islands. From Laurie's[117] investigation it was learned that these islands were submerged mountains with their peaks remaining above sea level. The islands lie in the belt of the prevailing westerly winds which blow from a west and northwest direction. The sky is overcast for four-fifths of the year with a heavy precipitation. In this respect it is much like Jan Mayen of the Arctic region. The January mean temperature barely exceeds freezing and the temperature for the coldest months in the South Orkney's is 11.1 degrees Fahrenheit. The warmest month is 32.7 degrees Fahrenheit. The tundra vegetation consists of mosses and lichens only. Frederiksen Island is a long thin mountain among larger islands. On this particular island are innumerable penguins. Their nests are hard and built in high places. Each year the birds return to hatch their young. Leopard seals eat some of the penguins.

The South Sandwich Islands have been little explored. Several of the small volcanic islands that make up this group are ice-capped. Emperor penguins abound here in great numbers.

The South Georgia Island is located the farthest north in this particular sub-Antarctic arrangement of islands. All along its coast, glaciers come down to the sea and cause icebergs to be present in the surrounding waters. This island

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117. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

is a folded mountain range with glacier filled valleys and a fiord coast. The snowline is between the elevation of 1,650 and 2,300 feet. Above that rise snow-capped peaks as much as 6,500 feet high. Mountains are enshrouded in fog and precipitation is excessive for it amounts to about 56 inches in the warmest month. The temperature during this month is about 10 degrees Fahrenheit. The effect of fohn winds makes the snow cover less on the northeastern side. Below the mountains is the tussock plain through which flows a fresh water glacial stream to the Bay of Isles. Tussocks are on the low foothills but mosses and lichens grow further up. Shocks of tussock grass are higher than man. Plant growth is dense with nineteen flowering plants and ferns and two hundred species of mosses and lichens which, make the interior tundra less varied. The Bay of Isles has a long, steep, shingly beach littered with dry seal skeletons. Kelp girdles the shore and fish are plentiful. The almost extinct elephant seal seems to be the only large animal in the ocean waters of South Georgia. Because of government regulations only the elephant seal bulls may be taken. Rotation plan in four fields allows hunting in three fields and none in the fourth region. Three whaling stations on the South Georgia Island have closed down. The whaling station at Cumberland Sound is still active. Cumberland Bay resembles a small village along whose coast are lighthouses and a means of communication with Buenos Aires. The Germans maintained polar stations there in 1882-1883.

Albatross, gulls, and penguins breed on the South Georgia

Island and reefs.

In the Atlantic quadrant of the sub-Antarctic the islands receive west winds because they are on the north side of the depressional trough. Because they lie in the trough of barometric lows they have heavy precipitation and severe storms. The islands have low temperatures with cold summers caused by the westerly winds. The coastal waters have seaweeds, sea elephants, and sea leopards. Whaling is done in the Atlantic quadrant. Mosses and lichens predominate but there are a number of flowering plants, too. King penguins, ducks, cormorants, petrels, Cape pigeons, insects, and worms are among the animal life found on the islands. Whalers collect penguin eggs for food. Penguins put to sea at the onset of Antarctic winter and return to the beaches and rocks in the spring.

Primitive man has never lived on these sub-Antarctic islands even though a modern, permanent settlement could be developed. South Georgia has served as whaling headquarters. The disadvantage of longer residence is the distance from the northern centers of civilization.

The sub-Antarctic islands of the Indian Ocean quadrant are Bouvet, the Marion group, the Crozet group, the Kerguelen group, the Heard group, and St. Paul and Amsterdam Islands. Snow and ice covered Bouvet Island rises abruptly to 2,950 feet. Its volcanic cone was discovered in 1739.

The Marion and Crozet groups, discovered by the French in

1772,[118] are located southeast of the Cape of Good Hope. France claims possession of the islands. Both of these island groups rise very steeply from a submarine plateau and are of recent volcanic origin. The vegetation consists of a dozen flowering plants and grasses. Swamps and inland moors are inhabited by sea elephants and penguins. Pigs and rabbits have been an innovation brought by the American sealers. Kelp is found along the shore. Since these islands lie in the west wind belt they have considerable fog.

The Kerguelen group, discovered in 1772, also belongs to France. This group consists of one main island and hundreds of minor islands and skerries. The volcanic tableland is tabular, terraced, and conical in shape and is cut by glacial valleys and inlets. Elevations range from 1,650 to 3,280 feet. Lakes are quite numerous. An ice covered ridge on the west coast has an altitude of 3,280 and ends in the crater cone of Mt. Ross, at an elevation of 6,500 feet. Glaciation of this group of islands is incomplete. An oceanic climate and low pressure cause an unstable weather. The mean annual temperature is 38 degrees Fahrenheit with a summer mean of 45 degrees Fahrenheit and a winter mean of 36 degrees Fahrenheit. The sky is always partly overcast and snow falls even in summer. The velocity of the wind remains between twenty and thirty miles an hour. Plants are rare on the windswept west side. Oases in the form

118. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

of tundra and heath are present. There are regions of tussock grasses and sub-polar meadows. Characteristic cushion plants are in the form of swamp and water plants, mosses and lichens, fungi and algae, and twenty species of flowering plants. Sheep raising would be possible on the islands. Animals now living along the shores are penguins, sea elephants, and sea leopards. Insects there have no wings. There are no living trees on the Kerguelen group though highly silicified trunks have been found. One fossil tree seven feet in circumference has been found.

The Heard and MacDonald Island groups of volcanic origin rise from a submarine bank. These groups were discovered in the 1850's. The high cliffs of MacDonald Island make it unapproachable. A landing can be made on Heard Island. Mt. Kaiser Wilhelm (altitude of 6,000 feet) is ice-capped with glaciers that descend into the sea. Vegetation consists of plant cushion and Kerguelen cabbage with some moss and lichen growth. Kelp is found along the shore. There are some flies and insects. Sea elephants come into the water pools. Birds visit the islands. The annual mean temperature of 32 degrees Fahrenheit makes them more polar than the Kerguelen group. These islands also lie in the belt of the prevailing westerlies. Heard Island serves as a whaling station.

St. Paul and Amsterdam Islands are the most northerly of the sub-Antarctic group in the Indian Ocean quadrant. The climate is milder and vegetation is more luxuriant. Amsterdam Island has thirty-three species of flowering plants predominated

by grass and shrub growth. At times there are permanent human habitants who raise chickens, cattle, potatoes and cereals.

The sub-Antarctic islands near New Zealand form six groups. Bounty Islands are almost bare. Macquarie Island, rising from a submarine ridge, has a high altitude of 1,400 feet. The prevailing winds blow from the northwest and west with a mean velocity of sixteen miles per hour and a precipitation of 46 inches. The range of mean temperatures is small with 45 degrees Fahrenheit for the summer and 38 degrees Fahrenheit for the winter. The temperature range is from 43 degrees Fahrenheit in January to 37 degrees Fahrenheit in June. The November temperature sometimes reaches the freezing point. A treeless vegetation of thick tussock grass or meadows and shrubs is characteristic of the lowlands. Kelp is found along the rocky shores. Penguins and many species of sea birds visit the islands. Auckland Islands are the largest. Auckland's shores are skirted with a low forest blending with brushwood and ending with grass on the hill summits. Ferns are plentiful. Snares Island has trees and ferns, also. Antripodes and Campbell Islands are no longer glaciated. The windward south and west sides have steep, high, jagged coasts. The stormy climate is cool and temperate. Two hundred species of flowering plants make a luxuriant variety of growth. A species of penguin which produces oil, the albatross, the sea elephant, and sea leopard are among the main animal life of these two islands.

PART II

POLAR TUNDRA

Broadview

Topography

The tundra region covers a wide belt on the Arctic margins of the continents of North America, Europe, and Asia in the Northern Hemisphere. In Greenland this marginal belt extends from the south to 65 degrees N latitude on the east and 72 degrees N latitude on the west. The small tundra area in the Southern Hemisphere is on the Kerguelen and South Georgia Islands and Tierra del Fuego.

A low plain is the characteristic land form of the tundra. The extensive lowlands are monotonous. Occasionally the land is elevated to plateau heights. This is true of eastern North America, northern Europe, and central Siberia. Mountains are few. Those that have the most important significance are the Torngat Mountains of Labrador, the Northern Ural Mountains of the Soviet Union, and the many ranges of eastern Siberia. As the elevation in the tundra increases snow and ice become dominant.

The tundra has many important rivers. These streams flow

slowly because of the ice condition at their mouths, the low stream gradient, and the frozen sub-soil. The rivers furnish power and a transportation system for the natives and traders. The drainage is so poor that a large number of lakes have been formed. Such lakes may be useful as emergency landing fields for trans-Arctic airlines.

Two areas in the tundra show similar glaciated conditions. They are the Laurentian Shield of Canada and the Baltic Shield of Europe. Glaciers exposed the rocky surface and left many lakes. In the lower depressions soil is very thin.

The soil and landforms are caused by frost action, glaciers, wind, and water saturation. Ice mounds of different size and shape, caused by local up-doming of the hydraulic force of ground water which freezes in the opening, are low and scattered. Some are only a few feet high, yet there are many measuring tens of feet in circumference. The ground over the ice mounds is broken by tension cracks forced by the expanding cores of ice. The alternate process of freezing and thawing causes soil to form (1) polygomal cracks in irregular hexagonal rows on level ground, (2) stone circles about upraised clay areas with the finer material toward the center and the coarser gravel toward the edges, (3) striped ground with a general pattern of coarser and finer gravel and sand in the direction of the slope, and (4) plant formations in tussocks and moors.

Sub-soil in the tundra is frozen to variable thicknesses. Polygonal soil is restricted to areas where the land is almost

always continually frozen, where there is endless water saturation above a sub-layer of frozen ground, and where there is frost, evaporation, and sliding.

Mechanical weathering causes the soils to be rocky. Loose, angular, rock fragments are found in this soil. Because of the thin humus, the soils are infertile and undergo little chemical change. The layers of the soil are a raw humus or a peat top, below which is a gray top soil two or three inches deep. Below this is a grayish-blue, semi-fluid, sticky loam. The low surface evaporation causes the soil to be highly leached.

Climate

The tundra is the warmer of the main belts of the polar region. The temperature is one of the most important factors for determining the limits of the tundra. This region is characterized by its cool summers more than by its cold winters. The short summer has a cool temperature range even in the warmest month. One month has an average temperature above 32 degrees Fahrenheit but not above 50 degrees Fahrenheit. The warm month isotherm for the July average is 50 degrees Fahrenheit. Arctic snow melts late in June and leaves the soil saturated with ice cold water. When melting takes place the air temperature is about 38 or 39 degrees Fahrenheit. For two to four months the average temperature is above freezing. More effective insolation is necessary to raise the polar temperature. The temperature makes a water-logged condition and an atmosphere that is damp and raw.

The tundra is noted for its long severe winters and short

summers. Seasonal changes are in the form of daylight and darkness. North of the Arctic Circle the sun may remain above the horizon from one day to five months. Winters in the tundra have extreme conditions caused by winds blowing in from the sub-arctic region. Seasonal weather begins with variable winters which, for the most part, are anticyclonic. Fair weather areas prevail with some clouds and a meager snowfall. These high pressure areas are better developed in winter. The dryness of this weather causes a torturing thirst. The moonlight of winter is an aid to the hunter. The period of darkness in the north is anticipated as mid-winter vacation time for the natives. In spring there is dazzling sunlight. The summer anticyclone brings clear cool weather slightly above freezing, and accompanied by strong solar radiation.

The prevailing winds of the tundra are north or northeast. These winds are strong and cause great evaporation. Violent gales are expected wherever high land faces open water.

In the tundra the uniformity of the earth's surface and temperature are characteristic of the polar source region. There are numerous frontal zones having characteristics of low, middle, and high latitudes. Some of the air masses originate over the snow covered plains of Canada and Eurasia. The Polar Pacific air mass in winter originates over the Arctic seas, and over the arctic and sub-arctic interiors of Siberia and Alaska. This air mass is warmed by the ocean on its way to the continent. In winter there are greater variations of cold. The farther inland, the colder it is. The climate is continental

over the continents for the large land masses accentuate all temperature extremes. The land type of polar climate is more or less continental even near the coast close to the Arctic Circle. The vertical extent of polar cold air masses becomes shallower as summer approaches. The summer polar continental air mass contrasts to that of winter. The warm land surface tends to heat the air from below and give it qualities of dryness and coolness without snow. In the summer, the primary source region of the Polar Pacific is the same as for winter except that it becomes more modified. The cool water stabilizes the air passing over it and makes it drier. The polar maritime climates invade along the northern and eastern parts of the Atlantic and Pacific in the winter. This air is usually invaded by the air of the polar sources and, therefore, does not have a chance to remain long.

Although the tundra has a slight precipitation of five to twelve inches annually, there is no drought in this part of the Arctic. The summer thaw and the poor drainage account for the wet conditions. The western areas of the tundra receive the greatest amount of precipitation because the cyclones pass these sections first. As the polar air masses move over surfaces that are warmer, they cause the low air masses to become unstable and increase the moisture content of the lower air by evaporation from the warm surface. The maximum precipitation falls in the spring and autumn. The most severe storms occur in the autumn. They are sometimes blizzards. Winter snowfall is compact and meager, very dry and powdery, usually

accompanied by blizzards which cause much drifting. There are two inches of snow to one inch of rain. Seventy-five to ninety per cent of the tundra area is snow-free because of strong winds. Gushes of cold polar air cause the formation of storms. In the summer the gushes are weaker and therefore the storms occur more polarward. Fogs are frequent and common during the long summer days. During the winter fogs are rare except in the transitional belt around the Bering Sea and the Japanese Current.

White and Renner[119] say that the climate is benumbing rather than stimulating because the occupants are slow and dull. Other authors say the climate gives bracing vigor.

Winter in the tundra is preferred by explorers because the frozen surface provides the best travelling conditions.

The tundra is cold but not too cold for human habitation during the winter. The Arctic coast has no record of -55 degrees Fahrenheit but the United States has five such records. Fort Good Hope, on the Mackenzie River, twenty miles south of the Arctic Circle, is the coldest spot in North America with -79 degrees Fahrenheit,[120] yet potatoes can be grown there. Peary, in Peary Land, at the northern tip of Greenland, saw bumblebees and butterflies visiting flowers in the summer.

The temperature and vegetation boundaries seem to coincide. The location of polar climates from intermediate latitudes has

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119. GEOGRAPHY AN INTRODUCTION TO HUMAN ECOLOGY, White and Renner.
120. THE ARCTIC IN FACT AND FABLE, (Headline Series), Viljhalmor Stefansson.

the poleward limit of forests.

Plants

Two changes have taken place in the evolutionary history of organisms in the polar regions. The early period climate was warm or temperate and produced a different flora than that found there now even where the Arctic summers are warm. A climatic deterioration has followed the ice age for a part of the American Arctic Archipelago was ice free during that period.

The enemies of tundra vegetation are cold, frozen ground at insignificant depths, an improper distribution of moisture, and wind because it increases evaporation. The advantages for vegetation in a short growing period are the steady summer temperature, constant radiation, and the indirect effect of radiation from the ground.

There are three types of tundra, the bush tundra, the grass tundra, and the desert tundra. The tundra region is practically treeless and is at least devoid of close or luxuriant tree growth. The bush tundra lacks tall trees because they need a temperature of 50 degrees Fahrenheit for a July mean. The number of dwarf trees are therefore abundant. Vegetation in this tundra has stunted willows, aspens, birches, and alders. They lose their leaves in September. In the grass tundra, which is sometimes referred to as "Arctic Prairies" or "sub-polar meadows", are shorter growths of willow, aspen, birch, and alder along with berry species, heaths, poppies, Alpine chickweed, bluegrass, mountain avens, cat's paw, blue

bell, arnica, saxifrages, reed, wool, and whitlow grasses, dandelions, timothy and scouring rushes, ferns, edible mushrooms, sedges, mosses, and lichens. Here the high summer temperature causes the lack of ice. In protected places the vegetation can be relatively luxuriant. On the mountian tops the grass tundra receives the name "alpine meadows". Tundra plants have characteristic leather-like leaves, a tendency to succulence, hair-like coverings, tussock formation, low stature, and very short stems. Sometimes bushes and grasses are one-sided. The windward side dries up and the dead parts do not easily decompose. The desert tundra is lacking higher plants. Its vegetation is the closed meadow or heath type and has uniform creeping bushy plants of sedges, mosses, and lichens. Its value is as food for reindeer and musk ox.

In the Arctic tundra there are 762 species of flowering plants, 332 species of mosses, 28 kinds of ferns, and 16 species of cress. One hundred and twenty species have been gathered north of the Arctic Circle.

The plant cover of the tundra gets most of its moisture from the melting snows, from thawing ground, and from fog. Luxuriant polar vegetation is found in moist valleys which are protected against the wind.

Research about Arctic plants could be done to determine the water requirements, how they grow on frozen ground (subsoil), how they grow by runners, how rapidly they blossom and mature, and how environmental conditions would effect them if they were transplanted.

Animals

In the Arctic the dwarfed vegetation growth is contrasted with the large size and number of animals. The animals are restricted for the most part, to the ice free coasts and the tundra. Where there is luxuriant vegetation, animals live best. The better known animal of the tundra is the reindeer. This animal was introduced to North America from Siberia in 1891.[121] The reindeer project in Alaska failed. Two experiments are now underway on the islands of St. Lawrence and Nunivak. Alaska could support about four million head for they could pasture on the prairies, the islands of the Bering Sea, the Bering Coast, the Arctic coast, and upland mountain regions. Canada could support about forty million head on grazing territory from the Mackenzie delta to Churchill. The Soviet government is anxious to expand their reindeer production in their five year plans for they could support one hundred million head. The reindeer is useful for its meat, hides, and transportation. Stefansson is of the opinion that it could be used for meat in civilized nations if the wolves were exterminated. Reindeer feed upon lichens in the winter and grasses in the summer.

The caribou differs from some of the Arctic animals because he leaves his summer place to go to a winter one. The caribou moves south late in August, September, and October.

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121. Headline Series, THE ARCTIC IN FACT AND FABLE by V. Stefansson.

During November and December, it moves northward to the coast for this is the period of increasing cold. Both the caribou and musk ox gain fat in cold weather.

The habitat of the musk ox is the Barren Grounds, the Arctic Archipeligo of America (except Baffin Island), and northern and eastern Greenland. The musk ox prefers the cold and therefore ranges farthest north. At Coronation Gulf, the musk ox is scarce and to the west of the gulf it disappears entirely. These animals live on the grass which grows in the polar lands. Their milk is as rich as cow's milk, their wool of good quality, and they make better domesticated animals than the reindeer because wolves do not attack them. The musk ox is now protected by law. They furnish excellent meat and a warm, light wool. No musk ox grow in Siberia.

The horses of the Arctic are the Iceland and the Siberian ponies. They forage for themselves and therefore require no barn or hay.

The blue and white polar foxes feed on the swarms of lemmings. The wolves and foxes of the tundra prey on other animals. Wolves usually travel singly or in packs of ten or less. The musk oxen do not flee from the wolves. Instead, they form a defensive ring which eventually discourages the patience of the wolves so that they slink away.

In the tundra areas there are many kinds of birds. Geese, brants, swans, cranes, screaming loons, and many species of ducks abound in the swamps. Owls, hawks, gulls, guillemots, terns, and auks occupy the cliffs by the thousands. Eider

down is gathered in certain parts of the Arctic where as much as a pound can be collected from fourteen birds. Plovers and snipes breed in the tundra. Insect eating birds live in the willow bushes. Some arctic birds burrow in the winter.

The numerous insects make the life of both animals and men miserable. The swamps are filled with swarms of mosquitoes and black flies. Blue-bottle flies are plentiful also. Butterflies and beetles visit the luxuriant vegetation of polar lands. The north is not a silent place because of the buzzing insects and noisy birds.

Inhabitants

The population of the Arctic fringe totals about thirty thousand people of two races, the Mongolian with unrelated languages, and the Eskimos who have Indian and Mongolian traits. Russia's northern cities are populated in the tens of thousands while ours have about two hundred. Men in the arctic regions live mostly on land. The Eurasians are inland dwellers. In America their homes are located on islands and peninsulas as well as along the coast. Both are nomads and exist on animals. Plants are used sparingly. Moss is used for lampwicks and angelica is eaten as a delicacy which serves as a confection for Siberian peoples. The Siberian goes into the forest in the autumn and lives on berries, tubers, and nuts. He uses wood for fuel and his utensils. Salmon, cod, and halibut are the fish preferred by the tundra tribes. The contents of the reindeer stomach are a delicacy. Meat is eaten raw, frozen, cooked, and rotten. As much as fifteen pounds of raw meat is

consumed per person in a half day, most of the time this does not include the fat consumed. Arctic man has a well-rounded body and his layers of fat help him to resist hunger for a long time. His movement and mode of life follow the laws of the animals. The people of the tundra have a low culture yet they have accurate powers of observation of nature and acute senses. They have a spirit which is carefree, easy, good-natured, and happy. Their tribes have no chief and therefore there is a communistic anarchy.

Due to the intensity and long duration of the cold and darkness, a polar hysteria sometimes overpowers the people. Women are the usual victims. Serious forms are similar to epilepsy and the results are a temporary insanity. Hunting is neglected during the period of greatest darkness.

The huts, tents, and igloos are crudely constructed from the materials at hand. Tundra natives and explorers have learned that sleeping bags of eiderdown rather than reindeer skin are better for use in tents. In the shelter it is necessary to have a stove going to thaw out the frozen dampness which accumulates on the clothing due to condensation. Clothing in the Arctic is for the purpose of insulation. Many layers of thinner clothing are proper to prevent perspiration which can be dangerous.

The tribes of the tundra have been well treated and have grown less dependent upon their own environments due to the trade and contact with white men. White people have profited from the Arctic in furs, whale and seal fisheries, and

minerals.

North American Tundra

Topography

The tundra region of North America extends from Bering Sea on the west to the Atlantic Ocean on the east, and from the Great Northern Forest on the south to the Arctic Ocean on the north. The topography of this area is variable. The character of the Arctic coastal plains is monotonous with depressions which are swampy, bare rocks, low birches, and willows. The plateaus are icy and the mountains are glaciated. The many streams are tortuous with estuaries which are divided to form distributaries.

John Franklin and John Richardson discovered most of the Canadian coastline in 1819 and 1825. Between 1825 and 1827, John Franklin explored the margins of the continent and surveyed the coast on both sides of the Mackenzie River.[122]

Canada has five hundred thousand square miles of tundra lying north of the Arctic Circle and many more that are south of it. The Canadian Shield, on which the major portion of the tundra lies, is a stable area which has been glaciated. Throughout the Shield, there are many lakes, the largest of which is Great Bear Lake.

Polar Alaska is separated from the central region by an Arctic mountain system. The low relief is of the tundra type

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122. THE GEOGRAPHY OF THE POLAR REGIONS by Otto Nordenskjold and Ludwig Mecking.

and produces a tundra vegetation due to the short growing season of forty days.

The prairies of Polar Alaska are on the northern and western sides of the continent. On the Arctic side of Alaska, the flat coasts are divided by headlands, river mouths, deltas, lagoons, barrier beaches, and islands. Embedded in the broken shore bluffs are ice deposits. Arctic Alaska has ice free areas with permanently frozen ground. The coastal lowlands change to a gently rising peneplain and then to Brooks Range which is a folded area attaining an altitude of eight thousand feet. The Range is an independent mountain system which has not been glaciated. Along the coastal plain, there are earth hillocks thirty to fifty feet high. Often the hillocks have a depression containing a pond. On the plateau, the rivers have steep banks. The Nootak River flows west to Kotzebue Sound and the Colville River, with a lower course, flows north. The western side of the Arctic Alaska gives the impression of being submerged. The broad projecting ends have large areas of tundra whereas the heads of bays and headlands have little tundra. Lowlands adjoin the coast. Kotzebue Sound is surrounded by lowlands bearing young coal sediments and volcanic rock with lagoons, barrier beaches, and flat moors. Seward Peninsula has an area of 19,250 square miles with individual small hills and ridges. Nome district is in the southwest corner of the peninsula. Norton Sound has formations similar to Kotzebue Sound minus the lagoons, beaches, and moors. Harbor conditions are unfavorable in both sounds due to lack of

protection and water depth. Ocean vessels go to St. Michael on Norton Sound. Cape Vancouver has elevated strata 990 to 1,300 feet above sea level. The Yukon and Kuskokwin mouths have alluvial lands with many inland lakes. Eventually, it is believed, this region will produce great quantities of reindeer meat.

The Arctic mainland of Canada begins at Demarcation Point between Alaska and Canada. The Mackenzie River, explored from source to mouth by the Scotsman, A. Mackenzie, in 1789 or 1798,[123] is the only river of any consequence in this section. Its delta has a coastal extension of about ninety miles. The area of the Mackenzie Basin is approximately 682,000 square miles which is one-fifth of the mainland of Canada. In the east, it extends to the Laurentian Plateau where the hills attain elevations of 160 feet. In the west its source is in the Cordilleran region. The central and largest part is broad and nearly a level plain. The Mackenzie River is made up of a complex system of rivers and lakes. Many rapids break navigation. The most dangerous rapids are on the Slave River between Fitzgerald and Fort Smith where they drop one hundred nine feet in sixteen miles and have five falls. The Mackenzie is navigable to its mouth and, in the current, driftwood is carried to the sea.

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123. THE GEOGRAPHY OF THE POLAR REGIONS by Otto Nordenskjold and Ludwig Mecking.

The coastal belt from Cape Bathhurst (the narrow tip between Liverpool and Franklin Bays) to Coronation Gulf has simple outlines. The Anderson River flows into Liverpool Bay. The boundary of the Canadian Shield comes through Coronation Gulf by the Lower Coppermine River. S. Hearne,[124] in 1771, reached the mouth of the Coppermine River. He received reports from the Indians that copper was found here. The Laurentian Shield is bordered on the west by Great Bear Lake and, in the southeast, by the Great Lakes. Eskimo Lakes to the east of the Mackenzie delta and west of Cape Bathhurst. These long lakes lie in back of the flat coasts. To the east of Cape Bathhurst are cliffs.

The peninsula of the Barren Grounds (where there are small islands lying from northeast to southwest in parallel rows) covers the eastward area from Coronation Gulf to the northwest shores of Hudson Bay, and from the forest limit to the northern coast of the continent. It is a part of the Laurentian Shield. The elevation of the Barren Grounds is 660 feet and Melville Peninsula is higher. The peninsula is irregular and has a polished and rounded-off rock surface consisting of sedimentary tableland and volcanic sheet. The rocky lowlands and plateaus have been caused by ice action. Between the rocks lie ponds, lakes, and swamps. The soil in the valleys bears tundra vegetation while much of the valley surface remains bare. Rivers flow into Chesterfield Inlet in northwestern Hudson Bay. The

124. THE POLAR REGIONS by R. H. Rudmose Brown, E. P. Dutton & Co., N.Y. 1928.

Great Fish River flows north. The steep coast has many fiords, bays, capes, islands, and reefs.

John Ross, in 1829 to 1833,[125] discovered Boothia Peninsula and fixed the position of the North Magnetic Pole at 70 degrees 5 minutes N latitude and 96 degrees 46 minutes W longitude. In 1903 to 1906, Roald Amundsen made surveys and observations near the north magnetic pole and fixed it at 70 degrees 30 minutes N latitude and 95 degrees 30 minutes W longitude. Colonel C. S. Irvine, in 1946, while flying the Pacusan Dreamboat from Honolulu to Cairo, confirmed the surmise that the magnetic pole is two hundred miles north of its location on standard maps.

Hudson Bay and its islands were founded by Henry Hudson in 1610 while he was searching for the northwest passage. This section is a part of the Canadian Shield. Hudson Bay is an Arctic epicontinental sea, shallow near the shore but reaching a depth of six hundred fifty feet in the deepest part. It has an area of 415,000 square miles. The shore, on the west side, is low while, on the east side, it reaches an altitude of 1,917 feet. Land is uplifting on the western side. According to fishermen, it has risen ten to fifteen feet in their lifetime. No glaciers are present. In Hudson Bay, Southhampton is the largest island. It has an altitude of four hundred ninety feet. It has many ponds and is covered with blocks of rocks. Reefs and shoals surround the island. The ground is dry for the most part. Where the ground is more moist, high grass grows. Reeds

125. GEOGRAPHY OF THE POLAR REGIONS by Otto Nordenskjold and Ludwig Mecking.

grow around the ponds. Next in size are Coats and Mansel Islands, the smaller Nottingham and Salibury, and the Belcher Islands in the southeastern section. Hudson Bay is an exportation center for the wheat from Churchill which is ice-free for an average of six months. Since this port is an outlet to the shortest route to England from western Canada, the development of lumbering, mining, fishing, and fur trading should industrialize Churchill and make it prosper. Currents at the north and south of Hudson Strait flow in opposite directions. The northern current carries icebergs. The ice in the Strait breaks up after mid-July and navigation is possible for about four months.

The Canadian Shield extends eastward to the interior of Labrador but is indented by Ungava Bay along the Arctic coast. The latter is of sedimentary and volcanic origin. The rocky plateau predominates throughout Labrador. Its worn rocky surface has an increase in height from southeast to northwest. The Labrador Peninsula has been glaciated.

The eastern part of Labrador has an independent mountain system which is secondary in polar regions. The Torngat Mountains, with fifty-three glaciers, lie in the northeast. These mountains have risen from the sea to heights of one thousand to six thousand nine hundred feet. The lower parts have been rounded by the ice sheet that left a bald rock condition. The higher parts are left peaked and ridged by local glaciers. Fiords are largest and widest along the

northern third of the very rugged Labrador coast. On the seaward side of the middle coast, there are many rounded inlets called skerries. Labrador has strand flats and low, rocky plains. The rivers on the coast of Labrador are numerous. They flow south, west, and north and make easy communication possible from coast to coast.

All three coasts of Labrador are hemmed in by ice for most of the year. In winter, the outer coasts have fields of thick ice which, in the spring, become drift ice. Along the Atlantic coast, the land seems to be rising.

Newfoundland has tundra at elevations of one thousand to twelve hundred feet.

Climate

The Arctic borderlands of North America and the northerly island groups lie within the tundra which extends to the southern boundary lying southeast from the Yukon River and Great Slave Lake to the middle of James Bay and on to eastern Labrador. On the North American continent, within the Arctic Circle, there are no peaks or mountain ridges known to rise above the line of perpetual snow. The tundra climate of North America is nearly free of snow at all seasons and the temperature is generally higher than in other tundras. Most of the area is frozen permanently. In some places, it freezes to a depth of two hundred feet. The northern coasts are not quite so cold as the interior because of the ice-covered seas and channels. The polar sea is 30 degrees to 40 degrees warmer than the land in the winter. High humidity along the coast

makes the cold more penetrating. The interior cold is intense especially at the valley bottoms.

The anticyclonic polar air masses travel from the Arctic plains and the North Pacific Ocean in southeasterly courses. The Polar Pacific front has a temperature difference between the cold monsoon of Asia and the tropical maritime air of the Pacific in winter. In winter, the anticyclones originate over the snow and ice-covered areas of central interior and northern Canada north of 50 degrees -55 degrees N latitude, and in cold Alaska, and the Arctic Seas. They bring cold waves and bitter winter weather. The weather at this time is cold, dry, and clear with practically no clouds. It is ideal for terrestrial radiation during the long winter nights. It is an ideal source region for it has a uniform surface and relatively stagnant anticyclonic air conditions with diverging winds. Cold waves are caused by a southward movement of this air mass. They are more frequent in winter and are sometimes accompanied by blizzards. The air mass gathers moisture by evaporation of ground water and water bodies. This cold air mass subsides when the upper strata is warmed to give it intensity and increased atmospheric stability. The mechanical turbulence caused by mountains agitates the lower strata and disturbs the temperature inversion near the ground.

In summer, the polar fronts are more northerly and temperature differences are great along the northern coast of North America. The summer air mass properties are different from those of winter polar continental air masses. In summer, they

are heated from the ground rather than chilled; they have a fairly low moisture content; low humidity; and there is favorable surface evaporation by insolational heating during the day and radiational cooling by night. Thus the climate is considered dry for this latitude. The sky is cloudless because the condensation level is so high. As the polar continental air mass moves south, it increases in instability. When the polar continental climate reaches the abnormally cold North Atlantic waters off Newfoundland, Labrador, and Greenland, it changes to the polar Atlantic. The air is chilled and, because of this, there has been created a stability which causes the clouds to become thin and broken. Rain is unknown except with cyclonic activity in the summer. The Polar Atlantic front, in winter, has the temperature contrast of a cold North American continent and a warm Atlantic Ocean. Cyclonic storms develop south of Newfoundland and are carried to Europe by the prevailing westerlies. The vertical extent of the polar air masses is more shallow than that of tropical air masses.

In the Canadian tundra, the coldest mean winter temperature is -30 degrees Fahrenheit. The temperature is the principal reason for plant growth. Autumn is usually warmer than spring.

Dr. Rae, M'Clintock, and Coffin seem to agree that the prevailing winds of North America are westerly and north westerly at 84 degrees N latitude. Coffin says the prevailing winds are easterly and north easterly between 60 degrees N and

66 degrees N latitude but Maury says they are westerly.[126]

Summer precipitation is in the form of showers and fog; snow may fall. Winter precipitation is in the form of snow.

There are seasonal changes in daylight and darkness for, north of the Arctic Circle, the sun may remain above the horizon from one day to five months.

Alaska's climatic conditions are maintained by its latitudinal extent. The temperature of the oceans is warm and even without ice in winter on the Pacific side. The variation of the mean annual temperature is from 10 degrees Fahrenheit in the north to 40 degrees Fahrenheit in the south.

The temperature on the Seward Peninsula is above freezing for five months. August has cold rains, fog, and raw winds. The coast is free from drift ice during this five months period. Winters on the Seward Peninsula are damp and windy with the lowest mean temperature of -36 degrees Fahrenheit.

In the tundra of northwestern Alaska, the climate is extremely arid with some damp fogs, occasional showers, and a small snowfall which is swept away by the winds. The climate along the Alaskan coast of the Arctic Ocean is warmer in winter. Summer weather is damp and cold with an overcast sky. Three miles inland, the summer climate changes to a stable, clear, and warm one. The temperature, inland, in summer, is 86 degrees Fahrenheit, and, in winter, it is -80 degrees Fahrenheit.[127]

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126. THE POLAR REGIONS by Sir John Richardson, Edinburgh, Adam and Charles Black, 1861.
127. THE GEOGRAPHY OF THE POLAR REGIONS, Otto Nordenskjold and Ludwig Mecking.

Point Barrow, the northernmost point in Alaska, has a temperature range from -56 degrees Fahrenheit to 78 degrees Fahrenheit.[128] Its minimum winter temperature is above that of Montana and North Dakota.[129] Its maximum summer temperature is equal to that of New York City. The growing season is seventeen days and the annual precipitation between five and twelve inches. Winds are strong.

The ice break up in the northern rivers is usually from the headwater of the streams to their mouths which empty into the Arctic Ocean. The climate of the tundra limits the use of the Mackenzie River by effecting the depths of the water. Winds are high. In the lower Mackenzie Valley, the temperature falls to -70 degrees Fahrenheit and the mean average temperature is below freezing for eight months of the year. The air is dry, calm, and invigorating. Fort Good Hope, near the Arctic Circle, has below zero temperatures for all but three months. It has the lowest recorded temperature in Canada, a -79 degrees Fahrenheit.[130]

In the Mackenzie delta section, the recession of the coast makes for a more continental climate. The summer temperature is 80 degrees Fahrenheit and, in winter, -60 degrees Fahrenheit. The continental type climate extends over the whole of the Mackenzie region up to 62 degrees N latitude. Ice on the Great Slave Lake becomes 60 to 70 feet thick and,

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128. REGIONAL GEOGRAPHY OF ANGLO-AMERICA, White and Foscue.
129. FOREIGN AFFAIRS, April 1939, Vol. 17, No. 3.
130. THE CLIMATES OF THE CONTINENTS, W. G. Kendrew.

on Great Bear Lake, 80 to 90 feet thick. The ice breaks up at the end of May but, even in July, it does not melt completely. Summer is oppressive for the white population because of the heat, the dazzling sunlight, and the mosquitoes, which swarm about for one to three months. In the delta of the river, the ice is out by the last of May and freezes again by the first of November. The river is navigable to the mouth. Large amounts of driftwood are carried to the sea in its current. Usually, in August, ships arrive at the mouth of the Mackenzie by way of the Arctic Ocean.

The temperatures of the Barren Grounds are lower. The January mean temperature falls below -20 degrees Fahrenheit and the June temperature is 37 degrees Fahrenheit. The forest limit drops in a rather straight course from the mouth of the Coppermine River to Port Churchill. The Barren Grounds have less than ten inches of precipitation a year.

Boothia Peninsula, located northwest of Hudson Bay, probably has the lowest mean temperature of Canada, a -35 degrees Fahrenheit.

Around Hudson Strait and Southern Baffin Island, the climate of the Canadian Arctic differs from the rest of the Arctic. Here the maritime influence is most pronounced and the mean temperature is not so low. The temperatures are usually above freezing every month. The precipitation, falling most in summer, is from fourteen to eighteen inches. The winds are continuous and high, and there are six to thirteen days of fog during the months of June, July, August, and September. The

shore around Hudson Bay is mostly tundra. Tree growth bends south around the bay. Spring is late and cold while autumn gives some warm sunny days. Churchill has never had a January temperature above 32 degrees Fahrenheit and has had temperatures as low as -57 degrees Fahrenheit.

In Labrador, the temperatures are cooler than in eastern Siberia. In summer, the Labrador climate is cool and foggy with a mean temperature below 50 degrees Fahrenheit. July is the only month without frost. Westerly winds predominate over Labrador. Precipitation, amounting to twenty or twenty-five inches, falls mostly in the late summer. Generally speaking, the precipitation is meager in the tundra area east of Hudson Bay except for the Labrador peninsula.

The Labrador Current brings many climatic disadvantages such as cold and fog to the Labrador coast. This inclement weather makes the coast barren and bleak. The climate is steady. The sea freezes first in winter and, from then on, the real Labrador cold sets in. The soil remains frozen from the last of October until June. In winter, the three Labrador coasts are hemmed in by ice which, in spring, breaks up into drift ice. Nain, on the Labrador coast, has midsummer icebergs. The temperature along the coast varies within short periods depending upon the direction of the winds. The winds from the icy sea are cold and, from the interior, are warm. In the north, the Eskimos hunt walrus and seal. Sealing starts in March. Heavy ice is still along the coast in June and icebergs form at this time. In August, the berries mature; in September,

the caribou wander southward; and, in October, snow falls. At a distance of two or three miles inland, there is sometimes warmer weather and the cultivation of crops can be carried on. The fiord heads have forests of spruce, pine, and birch.

Vegetation

The natural vegetation of the tundra zone is dwarfed. Tree growth is prevented by the wind. Lichens and mosses are the most natural vegetation and are underlain by a strata of earthy material.

Along the Arctic coastal zone of North America grow four hundred species of flowering plants. The northeastern projection has grass mats and meadows. Grassfields "like English meadows"[131] are as far north as five hundred miles beyond the Arctic Circle. For this reason it is believed that grains could be raised in certain tundra areas. Forests of spruce, cottonwoods, birches, and willows in North America grow one hundred fifty miles beyond the Arctic Circle.

Grass and tundra growth are found on the lower valleys and near the Bering Sea. In Polar Alaska there is stunted vegetation due to the short growing season of forty days. Along the Noatak and Colville Rivers there are dwarfed willows which are used by the Eskimos for fuel and the framework of their moss or sod huts. Eskimos use driftwood, also, but it is lacking in some places such as from Herschel Island to Point Barrow.

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131. ULTIMA THULE by Vilhjalmur Stefansson.

In the Mackenzie River valley, tree growth straggles to beyond the seventieth parallel. Along the Mackenzie delta, there is growth of birch, poplar, bush, and high grass in meadows. Agriculture has pushed farthest north in the Mackenzie basin and does not vary much from year to year. Carrots and cabbage are raised in the Mackenzie delta one hundred miles north of the Arctic Circle. Potatoes grow twenty miles south of the Circle and strawberries and other cultivated fruits are produced in this region five hundred miles north of Edmonton. Cereals such as rye and barley are raised near Great Bear Lake.

Trees also grow along the Coppermine River to within twenty miles of the Arctic Circle. Mosses and lichens dominate the plant forms of the Barren Grounds. The southwestern part of Melville Peninsula and southern Prince Patrick Islands have rocky portions though the remaining area is like English meadows.

On Southhampton Island, in Hudson Bay, the ground is usually dry. Where there are more moist places, high grass grows and reeds grow in the ponds.

The plant life of the Arctic tundra zone of Labrador includes dwarf birch, heath of lichens and mosses, flowering plants, stunted conifers, and willows. In the transitional belt, the vegetation consists of a poor spruce and alder, stunted and contorted balsam fir and black spruce, mountain ash, mosses, lichens, and berry shrubs. The branches of this plant growth are often longer than the stems. Fiord heads in Labrador have forests of pine, spruce, and birch.

Animals

Water life in the coastal tundra includes fish, sea-elephants, seals, and walruses. The Eskimo does most of his hunting on the sea. He knows the intimate habits of all the sea animals and locates his village with respect to favorable hunting grounds and water. Seal is the most valuable catch for, from it, the hunter can make shelter, clothes, and fuel. The Eskimo hunts for seal, walrus, and polar bear during the winter moonlight when the ice is firm. He also uses a kayak. The spring is his hunting season, too. Land hunting is not so important for an Eskimo but he hunts for caribou, hare, fox, and birds.

Animals of this region are the hare, fox, caribou, ermine, lemming, musk-ox, wolf, and polar bears. Trapping of these tundra animals is done mostly by white men who seek their pelts. The white Arctic fox has been badly exploited. White men, with the aid of the airplane, have taken so many that they have caused the natives to migrate or starve. The lemming is never found outside the tundra.

Birds are abundant along the Arctic coastal zone. They include the snow owl, gerfalcon, raven, and snow bunting. In the northeastern section, there are ninety-eight species of birds. The eider duck is rarely seen.

Swamps are filled with mosquitoes and flies in the summer. They plague both man and beast. Sandflies are another nuisance and are worse than mosquitoes because they get inside clothing and crawl.

Fish of Canada are distinguished for their flavor. The Indians catch the salmon on their way to their spawning grounds.

The caribou used to pasture along the Arctic Ocean but now they are almost extinct. Reindeer have been introduced from Lapland. It is said that, in northwestern Alaska, a square mile of land will support twenty five to thirty reindeer permanently. The blue Arctic fox, especially valuable in the fur trade, is hunted here. West of Point Barrow are walrus. Bearded seal are taken for their hides that are particularly useful for boots and boats. The polar bear is an infrequent visitor. Ducks and eider ducks are abundant. Very little whaling is done in the waters off Herschel Island because white men ruined the Eskimos' luck.

In the frozen wastes of Alaska, the remains of the mammoth are found less frequently than those of the giant bison, ordinary lion, an extinct type of musk-ox, elk, bear, a vanished giant wolf, beaver, and the little ground squirrel.

The so-called "big trek"[132] was the introduction of reindeer to the Arctic tundra of North America. The Canadian government wanted to stock the east delta of the Mackenzie River with three thousand head.

The Arctic hare lives in the barren and semi-barren land. The Arctic grasslands have tens to hundreds of thousands of caribou to a single person. The two kinds of caribou, the woodland and the barren ground, are decreasing at an alarming

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132. REGIONAL GEOGRAPHY OF ANGLO-AMERICA by White and Foscue.

rate. Caribou migrate, in winter, to the timber and, in summer, to the rocky mountains for grass and to avoid the flies. The musk-ox finds a natural habitat in the Barren Grounds. The wolverine, wolf, polar bear, and the barren ground bear live in the tundra outside the forest. The muskrat and the grizzly bear remain on the prairie with the other animals in the winter.

Animal life on Southhampton Island is not abundant but there are reindeer, foxes, and wolves. Many whaling stations operate along Hudson Bay because the Straits abound with seals, walruses, and whales.

The caribou is the game animal for the coastal and inland dweller between Hudson Bay and Labrador. The caribou ranges from Hudson Strait to Belle Isle. The sea animals in the north are important to the Eskimo who enjoys hunting them. Fur bearing animals of importance to the trappers are the valuable Labrador mink, foxes, otters, ermines, wolves, and rodents.

Labrador seems favorable for bird life since there are two hundred twenty-five species and ten per cent of them are permanent residents.

Inhabitants

The Eskimo natives of North America are apparently related to Asiatics because they have similar mongoloid characteristics and language. Speech unity has persisted among the Eskimos. As yet man knows very little about their early history. Some

Eskimos have Indian and Mongolian traits. The Eskimos are at home along the Arctic coast of the western hemisphere and in the transition zone where there are bushes of willow, dwarf birch, alder, and mountain ash.

Even though the northern two-thirds of Canada has a population of over one hundred thousand, the Eskimos number about thrity to forty thousand along the coast and off-shore islands. The tundra of North America has, relatively, few people. The central and largest area has the least number of inhabitants - about thirty-five hundred. They are divided into tribes and the tribal count varies from thirty to five hundred. Alaska has the next largest number and Greenland, the largest, has fourteen thousand.[133] Eskimo population still remains a problem in these Arctic regions.

The trade-mark of the Eskimo, all over the north, is a lamp fed by caribou fat in which a heap of dried moss serves as a wick.

The Eskimo of North America enjoys dressing in the strong, lightweight, warm caribou skin which has an air-filled cavity in every hair. The gauging of exposure and chill is shown most accurately by the Eskimo mother with her small children. In temperatures which range about -40 degrees Fahrenheit, the young child is stripped and placed against the mother's skin under the back of her coat. The air for breathing is provided by the channel between the mother's shoulder blades. On a

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133. THE GEOGRAPHY OF THE POLAR REGIONS by Otto Nordenskjold and Ludwig Mecking.

journey, if the child cries, the mother halts, takes the child out and places it on its back on a skin where it remains exposed for twenty to thirty seconds. When it shows some discomfort, the mother picks it up and slips it back under her coat.

The Eskimos of North America are men of the early stone age. They acquire the things they need by bartering. Among other tribes there is exchange of driftwood, steatite or soapstone, copper, and tobacco. They count by fives. Dead Eskimos are buried on the ground to be eaten by wolves. Communistic anarchy is present among the Eskimos because they have no chief. The one with authority is designated as "angekok". The cultures of the various tribes is a field open for study.

Eskimos have a varied seasonal life for the nature of winter ice governs their distribution. The ice is controlled by the coast, the currents, and the tides. During the winter, the Eskimo hunts seal, walrus, whale, and polar bears. Some authors say an Eskimo must kill a polar bear in order to attain manhood or marriage. In summer, hunters disperse over wide areas. At this time they live in tupiks or tents and ride in Kayaks on the sea. During this season much of the meat is dried. Some Eskimos have adjusted to pastoral life due to the introduction of reindeer. In winter, Eskimos are concentrated in larger settlements and live in igloos of ice or homes of stone and bone. The Eskimo has no defined

intervals for meals, sleep, and daily routine during the period of darkness.

The Eskimo uses every part of the caribou for food, clothing, and tents so that nothing is wasted.

For the last few centuries, Eskimos have been living in snow houses. The temperature within an igloo is usually 30 degrees below zero Fahrenheit. Igloo ventilation is controlled by gravity. The Eskimo arranges his igloo entrance at various levels to prevent drafts. This is a very successful air-conditioning method. The Hudson Bay Company posts have small units of population. The typical abode for such units is on a river bank or along the coast. The hostile Indians of Alaska and Canada forced the posts to settle in the tundra.

Transportation is by canoe in the summer and by dog team in the winter. Ocean going vessels come, in August, for the furs and gold. The airplane, carrying mail, medical supplies, and food, is also used by the men who are making accurate maps in mineral areas. In Hudson Bay there is a short season for navigation because of bad fog and ice.

The Eskimo's clothing of fur and his tools for hunting and fishing come from the materials at hand. In these ways the Eskimo adapts himself to his physical environment. His equipment is designed for the chase. The minerals he knows are soapstone, pyrites for kindling purposes, and the coal and gold that he mines.

The Eskimo is skilled in handicraft which is referred to as "culture of the hand". For his tools, he uses bones, stones,

clay, driftwood, and some copper and iron. He can make a sledge from frozen musk-ox hide. He has a sureness and accuracy in snowhouse construction. His boots, kayaks, and clothing have waterproof stitching.

Social adjustments among the Eskimos are lacking because of climate and mineral resources. Several authors claim that it is best to let these people live their lives as did their ancestors rather than conduct commercial relations with the white people. Eskimo commerce is negligible.

The Eskimos were the original inhabitants of the Seward Peninsula. Missionaries went there and were the first ones to be aware of the presence of gold. Today the population owes its existence to the gold in the sands.

Travel inland, for eighty miles is made possible by the narrow gauge railroad. Nome, on the south coast of Seward Peninsula, facing Bering Sea, is the white man's town and had a population of 1,559. The population of this metropolis has greatly decreased. More than half the people are Eskimos who should advance their arts and crafts. In winter, Nome is reached by dogteam and airplane. The tundra has been largely denuded and driftwood is lacking west of Point Barrow.

> "The Eskimo, under the influence of missionaries, are building their houses in the white man's way...houses from which they now try in vain to exclude the cold and dampness by burning fuel, whereas formerly they led a comfortable and healthful life in their well-ventilated snow huts warmed by tallow lamps."*

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* THE GEOGRAPHY OF THE POLAR REGIONS by Otto Nordenskjold and Ludwig Mecking, p. 194.

Barrow is the northernmost town along the Arctic coast of Alaska. It is a trading center for the entire coast and it has better village structures. In 1939, Point Barrow had only 28 residents.[134]

Aklavik, the trading center on the Beaufort Sea, has a varied population totaling two hundred. Its location is on the combined deltas of the Mackenzie and Arctic Red Rivers. Missions maintain a school and have a joint share in operating a hospital. It is the center of government services, police, wireless, and reindeer administration. Airline service is kept open all year.

Cape Bathhurst, along the Arctic coast of Canada, is the easternmost habitat of civilized Eskimos.

> "The Eskimos themselves are in close contact with one another eastwards up to this point, for example, through the manner of building their houses and the shape of their sledges; in the west the sledges are two meters long, at Coronation Gulf, four to seven meters long. At the latter place Stefansson met with coastal natives who had never before seen whites."*

The Copper River Eskimo has been in contact with white man since 1908.

The Eskimos along the northern edge of the Barren Grounds use the seal as their main animal food. Walrus is used for its pelt. The Aivillik tribe, about 150 in number, are the walrus hunters. During the time of whaling, they became more civilized and mixed racially with the Americans. In the autumn,

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134. J. C. Winston Encyclopedia Company, Philadelphia.
* THE GEOGRAPHY OF THE POLAR REGIONS by Otto Nordenskjold and Ludwig Mecking.

the Aivillik tribe move inland.

The interior of the Barren Grounds is inhabited by the original Eskimos who have maintained a relatively pure race. White man has influenced the Eskimos to the east and west but has not had as great an influence on these interior tribes. Their existence is based on the caribou and salmon. Caribou are killed during their migrations. The total population of the Barren Grounds is about one thousand.[135] The Caribou Eskimo in the interior area west of Hudson Bay endure and enjoy the long winter. They survive by using seals, the snow house, the blubber lamp, the Eskimo dog and sledge, and fur clothing.[136] Two types of winter homes are built by these Eskimos. Their one room homes are built of rocks with a sod covering and shaped like igloos or are built of snow. Some of their snow houses are built around a skin tent to prevent dripping from the roof. In summer, they use the sealskin tupik. The oil lamp furnishes heat and light. The Padlermiut or "People of the Willow Thicket" live on the northwestern coast of Hudson Bay. They are the most southern of the four Caribou Eskimo tribes. In winter, the Padlermiuts live in ice houses and in summer, in conical caribou-skin tents. These Eskimos drink enormous amounts of very strong tea. They have the Shaman religion. Clothes and food habits have changed for the Eskimos, but not their customary Stone Age dance.

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135. THE GEOGRAPHY OF THE POLAR REGIONS by Otto Nordenskjold and Ludwig Mecking.
136. REGIONAL GEOGRAPHY OF ANGLO-AMERICA, White and Foscue.

The Iglookik Eskimo, in contact with white man since 1938, lives on the Melville Peninsula. The Eskimo population at Iglookik is about one hundred fourteen.

Southhampton Island, in Hudson Bay, used to be inhabited by the Saglermiut tribe of about seventy people. Their dwellings were of limestone, whalebone, and sod. They were destroyed by an Eskimo tribe who were taken there by a whaling concern. The latter tribe killed all the caribou, the mainstay of the Saglermiuts, so that the island became uninhabited. Nottingham Island, also in the Bay, is still inhabited.

Churchill, on Hudson Bay, is located between the mouths of the Hayes and Nelson Rivers. About one-fourth of its residents are there because of the Hudson Bay Railroad which was demanded by the prairie province wheat farmers. In Churchill, modern grain elevators are found. Construction here favored small, one-storied buildings and the use of insulating material. Because of the frozen ground, installation of water and sewerage systems was difficult.

The Eskimos, or Innuit, of Labrador, live along the coastal tundra. Archeological work here would be worthwhile effort to reveal the ancient occupation of these Eskimos. They live as far south as Hamilton Inlet. Along the northern coast are missions and fisheries with white settlements and trading posts. The missions were founded by the German Moravian Brethren at Okkak, Nain, Hopedale, and three other places. Okkak is the largest and has a population of about

350.[137] The Moravians have worked well among the Eskimos and achieved much success in their work. The Eskimo population of the Labrador coast is about one thousand and the total Labrador population approximates two thousand. They are a vanishing race because tuberculosis and syphilis, brought in by the white people, have weakened them. Then, too, the males outnumber the females. The Eskimo race is destined for destruction because of over-hunting, adoption of civilization, miscegenation, the disappearance of the kayak, the replacing of the umiak by the motor boat, the use of cotton instead of fur for clothing, and the adoption of homes other than the snow huts. Today snow huts are used only for stop-overs on journeys.

> "It is also possible that a given people may leave numerous and lasting memorials through a period of centuries and may thereafter cease to leave them through other centuries. An example of this are the Eskimo of the north coast of Canada between Cape Lyon and King William Island and up into the islands of the north. A few centuries ago they used to live in houses of earth, bone, wood and stone, the remains of which are still conspicuous. But during the last one or several centuries they have been spending the winter in snow houses, which leave no sign. It is also true, at least in parts of this district, that formerly the people used to bury their dead in graves of stone or wood, which structures have remained and have tended to preserve the skeletons. But more recently there has come about a practice of laying the dead on the surface of the ground and of not protecting them from wolves or dogs, so that not merely are graves lacking but the skeletons themselves have little chance to survive. In other words, you find in this section many clear archeological proofs of Eskimos who were there five hundred years ago but few or no such proofs that they were there fifty years ago."*

In northern Labrador, where the Eskimo's food is principal-

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* ULTIMA THULE by V. Stefansson, p. 65.
137. GEOGRAPHY OF THE POLAR REGIONS by Otto Nordenskjold and Ludwig Mecking.

ly meat, they are well-nourished. The altered food and habits of the Newfoundland-Labrador Eskimos have made them thinner and less hardy. They smoke but don't drink. The most southerly Eskimos in the world live, at present, on the sound between Lake Melville and Hamilton Inlet, Labrador. In Nain district, the inhabitants are mostly Eskimos who hunt for animals and birds of the sea. Their summer homes are sometimes tents. Houses of driftwood or forest lumber are also used. Missionaries have encouraged the Eskimo to continue his nomadism. A century ago the homes of the Eskimos were either stone huts, igloos, or dugouts in the sodden slopes. They were unwholesome because of the dirt and poor ventilation. The most wholesome living accommodations they have known are the tents and snow-houses. Nowadays hunters want wooden houses. Hutton says that the Eskimo's square wooden hut is, at present, a very humble dwelling but it has immense advantages in comparison with the old igloo of turf and stones and a few rough beams.[138] A doorway leads into a square room. The air inside is not too bad although it is steaming, heavy, and warm. A tremendous fishy smell comes from the cooking. The floors are, usually, fairly clean.

Warmth is one of the most serious needs to be considered in the wooden house. The modern Eskimo has lost, to a great degree, the layers of fat which his forefathers possessed. The stove now has to substitute for body heat. There cannot be

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138. ACTA GEOGRAPHICA, No. 8, V. Tanner.

more than one stove in each home for firewood is too far away.

The clothing styles of the Eskimos are about the same because they are the most suitable for that climate. They have copied the styles of white women's skirts and have begun to use cloth for other garments, too.

The Eskimos are still fond of raw meat, especially seal. In order to maintain their health, they must avoid using white man's food for it lacks the necessary vitamins in quantities required for cold weather diets.

The economic foundations for the Eskimos has also changed because they trade with the white man for tools, etc. Missionary work has attacked this trade to prevent the Eskimos from falling into the hands of unscrupulous traders--especially those who deal in alcoholics.

Most Labrador Eskimos read and write. Eskimos are artistic and show this ability in their ivory carvings, their love for music, and their singing.

The half-breed Eskimos are dying out. The Eskimo population, farther north, remains static. The coastal Eskimo and the two tribes of the Indians of Labrador dislike each other but, as yet, white man has not found the cause. The Montagnais tribe that lives outside interior Labrador often hunts caribou ruthlessly.

The total number of Eskimos of the eastern Canadian Arctic was 7,700 in 1941.[139] Eighty per cent of the Eskimos are in

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139. GEOGRAPHICAL REVIEW, January 1945.

the eastern Arctic. There is one Eskimo to every one hundred sixteen square miles and they have less contact with the white men. They have a purity of race, are more primitive, and have a greater culture. A supply ship goes to them every summer.

White man has profited from the Eskimo by changing his trade, life, and settlement. Eskimo natives who have been influenced by the white men are suffering with diseases which were introduced by the latter. White man has brought about changes in trade, building, and the method of hunting. Firearms have caused a decline in the animal population. White man's influence has been felt strongest along the coast. The interior Eskimos have come out for supplies because of the disappearance of the caribou. On the coast the Eskimo can procure weapons, whaleboats, equipment, clothing, and supplies of sugar, tea, and butter.

White men, when settling in the Arctic regions, meet many obstacles such as the long, cold winters, isolation, pests, the high cost of transportation, and limited markets for their products. They have found that living is easier and more enjoyable if they adopt the Eskimo's way of life rather than continue their more civilized ways.

Nearly all the Eskimos of the Arctic are Christianized. They use white men's tools and are adopting the religion as well as civilization. The Eskimos are losing their racial characteristics as well as their igloos and purity of race. The future indicates the deterioration of the Eskimos chiefly because of the infiltration of white men who bring diets

deficient for the Eskimo, disease, and moral degeneration. The tundra still belongs to the Eskimos and white men will have to submit to their ways of living until more acceptable modes can be profitably adopted.

Minerals

The American far north is not a waste area. It is believed that mining there will increase. As yet, Canada has no immediate need for her Arctic regions.

Alaska has valuable raw materials which are scarce or missing in the United States.

Cape Lisburne, on the Arctic Ocean side of northwest Alaska, has rich coal fields. More coal seams are located to the northeast of the cape. The source for coal is one hundred miles wide, three hundred miles long, and from four to twenty feet thick.

Petroleum seeps from Cape Simpson in northwest Alaska. The United States has established a future reserve in this district which means that oil will be sought here.

The Norman Wells oil is located on the Mackenzie River, west of Great Bear Lake and was developed between February and April in 1942. The fifteen hundred miles of Canol pipeline stretch from Norman Wells to Whitehorse and Fairbanks. The Norman oil pool is the best potential source of crude oil in Canada with the exception of the Athabaskan sands. The former lies between the Norman Range of the Franklin Mountains in the east and the Carcajou Range of Mackenzie Mountains in the west. One well is on an island and the others are on the east bank.

Norman Wells oil will furnish an abundant fuel that will be cheap although coal, at Aklavik, sells for one hundred forty dollars a ton.

Bob Henderson found the pitchblende at Great Bear Lake but its value wasn't appreciated until 1930 when Gilbert Labine discovered this same pitchblende to be the source of uranium oxide and radium. Tungsten ore was also discovered.[140]

Copper is found in the Barren Grounds and there are even richer deposits at Bathhurst Inlet. This mineral is found on both sides of Coronation Gulf and on the Hudson Bay side south of Chesterfield Inlet. In Stefansson's "The Friendly Arctic", he states that native copper is found in amygdules and is widely distributed around Bathhurst Inlet.

> "The district of Coppermine, extending roughly 200 miles north from Bear Lake to the middle of Victoria Island and 200 miles east to Bathhurst Inlet--thus an area of about 40,000 square miles is commonly supposed to be one of the world's richest copper regions."*

"The natives use it in addition to their stone material and thus hold a special position as to culture among the Eskimo tribes."**

A new gold rush in the Yellowknife region north of Great Slave Lake has begun since World War II.[141]

Iron ores are found along the east coast of Hudson Bay especially at Nastapoka Islands.

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140. ALASKA AND THE CANADIAN NORTHWEST by Harold Griffin, 1944.
* THE ARCTIC IN FACT AND FABLE by Stefansson, The Headline Series, No. 51, p. 86.
** THE GEOGRAPHY OF THE POLAR REGIONS by Otto Nordenskjold and Ludwig Mecking, p. 201.
141. TIME Magazine, April 28, 1947.

European Tundra

Topography

The plateau of the Scandinavian Peninsula resembles the bottom of a boat. Its name, Kiolen, the keel, is very fitting. The Kiolen Mountains and the tops of the islands are old. These mountains are a climatic and boundary barrier. On the plateau are great snowfields, glaciers, and lakes. They regulate the flow of water and create the greatest potential water power in Europe.

Since one-third of Norway lies within the Arctic Circle, it is often referred to as "the land of the mid-night sun". In northern Norway, the main mountain range that divides the rocky coast extends into Lapland. There is good grazing ground on either side of the range.

Strand flats, or low rocky plains, are features of the narrow Norwegian coastal belt along which are situated the fishing villages. It is generally believed that ice-free islands may have fringed the Norwegian coast at the time of maximum glaciation and afforded a refuge for vegetation.

In Norway, the northern Scandinavian Highlands are a low plateau of Finmarken which have been uplifted during Atlantic sinkings. The old mountain system is located in western Norway and lies in the zone of folding so that it reveals sedimentary and volcanic land forms. The highlands have alpine crests and cirques which show the erosion that has left the surface smooth and rounded. There are scores of ice-caps and lakes of all

sizes on the plateau. The plateau glaciers cover 1,770 square miles from south of Bergen to north of Tromso. The largest glaciers in Europe are Jostedalsbrae, with an area of 580 square miles, and Svartisen, with 400 square miles. These glaciers do not melt in summer. Glacial denudation has left soils that are generally poor and patchy.

The northern part of Sweden slopes toward the east. The cold, barren mountain country has been glaciated and left with long, narrow lakes which are numerous on the highest part of the eastern slope. It is in this area that Sweden's iron ore district is located.

Swedish Lapland is in a lower altitude. The Norrland Plateau slopes gradually from the tundra mountain heights to the Baltic Sea. The Lulea-Narvik Railroad elevation is 1,712 feet above sea level. Snow sheds have been erected to protect the railroads in mountain crossings of the northern Scandinavian Highlands.

Finland, the republic farthest north, has one-third of its area lying north of the Arctic Circle. Due to this location, isolation is Finland's severest problem. In Finland, the important physical region is named the Finnish or Baltic Shield which resembles the Canadian or Laurentian Shield. This stable area is composed of glaciated ancient rock which presents no folding and almost no movement. The Finnish Shield forms a plateau trending east northeast and west southwest. In the north and east, the altitude of Finland is more than a thousand feet. Akavare Mountain has several peaks and glaciers

with snow that is colored red by the algae growth. The upland region has an old rolling surface. Very moderate hills reach above the timberline because it is so far north. The area from Rovanieni to Petsamo has an altitude of thirteen hundred feet. A great Arctic motor highway stretches 340 miles from Liinahama, on the polar coast, to the railheads at Rovaniemi.

Finnish Lapland is a continuation of the Scandinavian anticline and is, therefore, of greater elevation than the rest of Finland. Lake Inari drains into the Arctic Ocean. Rivers flow from a central watershed; eastward across the Russian border into lakes, northward to the Arctic Ocean, and southward to the Gulf of Bothnia. These rivers form a network which is broken by glacial lakes. The Tornio River opens the way through the tundra from the coniferous forest. The Arctic tundra is north of Lapland on the elevated areas.

Finland has done much to open the Petsamo region even though, as a port, it is handicapped by isolation. The Petsamo district is directly accessible to the Arctic Ocean because it is always ice-free. Petsamo Creek leads to Petsamo on Petsamo Fiord which remains open all year round. Glacial drift covers most of the surface of this important region. This area is closer to the United States, via the North Pole, than is southern Finland, which is almost isolated from it because of distance and transportation difficulties.

The soils of the northern area of Finland are composed of ancient, resistant rock, boulder-filled glacial drift, hills,

mineral wealth, waterpower, and hillside bogs. Under favorable conditions, polygonal soils occur in Lapland. Loess, the fine-grained soil of glacial mud, is carried and deposited by the wind.

Climate

The Polar Atlantic air mass effects the northern European countries of Norway, Sweden, and Finland. This air mass is variable depending upon the length of its path over the ocean. If it originates in the southern part of the source region, then the air mass is generally stable. If it originates in the northern part, it shows a mild instability and convective activity. Cyclonic storms are borne forward on the prevailing westerlies. The oceanic influence makes northern habitation possible in the Fenno-Scandia region. The marine climate is tempered by the Scandinavian barrier. The polar continental air masses of Europe have their source region in Fenno-Scandia and Russia. In summer, the polar continental air masses are warmer and more moist because of their previous marine influence. The northern polar fronts bring greater temperature differences. The average temperature is 10 degrees Fahrenheit above normal between 60 degrees N and 70 degrees N latitude. Inland, water freezes.

The Norwegian theory of cyclonic origin is that a wave separates air masses of contrasting temperatures and humidity along a surface of discontinuity. Such occurences take place in regions where air currents of different properties converge.

The plateau climate is very severe with long, cold winters

and cool, short summers. On the Kiolen plateau, the northern precipitation is 40 inches. The east is drier than the west, and the extreme north has less than ten inches. In the high areas, precipitation is scanty and accompanied by low evaporation which aids agriculture and forest growth. Early spring, in the Arctic, is frosty. The low altitude of the sun gives meager insolation and great inequality of day and night. The northern section has seasonal variations of long, dark winters and a summer mid-night sun.

Due to the marine influence, the temperature allows the harbors on the west coast of northern Norway to be open as far as North Cape during the winter months. The low temperature prevents white habitation except for a few settlements along the coast or in important resource regions. The most northerly climatic station at Freeholmen, inside the Arctic Circle, has an average February temperature of 26 degrees Fahrenheit. Precipitation in the far north of Norway exceeds twenty-five inches and is uniform throughout the year. On the hills of Norway, the winds are strong. Glaciers come down to the sea in some places.

The northern part of Sweden slopes to the east so that it has a continental climate with long, severe winters. Sweden feels the effects of the northerly latitude because it is shut away from the sea influences. The winters are more severe than the summers and have a very unfavorable climate. The cold even freezes the iron ore and makes it hard to handle. Laborers work only a short time.

"Innumerable observations have established the fact that the temperature of deep mines greatly exceeds that of the atmosphere at the surface of the earth; but the rate of increment, corresponding to the depth, varies with the locality."*

Rivers and lakes are ice-covered for two hundred days. The Gulf of Bothnia freezes the last of November and remains frozen until June. Sweden has a small tundra area in the far north.

The Petsamo district of Finland benefits by a weather station and air routes. The coastal region, because of the proximity of the Gulf Stream Drift, has a higher temperature than the interior. The February temperature at Vaitolahti, on the coast, is 19 degrees Fahrenheit. At Petsamo, twenty miles inland, the average temperature falls to 14 degrees Fahrenheit. The northern interior occasionally drops to -40 degrees Fahrenheit. Finland receives about ten inches of precipitation in the form of rain. Snow falls, in the north, from September until May. The ports of northern Finland are an asset because they are ice-free in winter. In the tundra region of Finland, there are periods of mid-night sun and continuous darkness.

Vegetation

Where no ice or snow covers the Kiolen plateau, there is tundra vegetation. The low Finmarken Plateau in northern Norway has depressions filled with peat moss. Birch is the most common tree north of the Arctic Circle. Northern Norway

* THE POLAR REGIONS by Sir John Richardson, Edinburgh, Adam and Charles Black, 1861.

has a very limited agriculture. Barley is grown to 70 degrees N latitude. Gooseberries grow at Hammerfest, on the west coast.

Inland, from the fringe of forest growth along the coast of the Gulf of Bothnia, is tundra forage for the support of reindeer. In Juntland, Sweden, the birch is the only tree. The strong winds on the hills cause stunted and unsymmetrical tree growth.

Above the timberline in Finland, the conifers disappear first. Birch trees grow the farthest north and become more and more scrubby then disappear. From Rovaniemi to Petsamo, lies the zone of timberless heath and marsh. The tundra has a thick vegetation with a shrub growing six or seven inches high and bearing a golden berry. There are many wild bushes such as blueberries, blackberries, redberries, and golden berries. They are picked, for native consumption, from bushes one foot or so in height. The Finnish tundra has a profuse covering of wild flowers, pink fireweed, white oxeye daisies, bluebells, red clover, and feathery grasses. Barley grows farther north than the Arctic Circle and oats grow to the Arctic coast. Many oats are cut green and dried on trellises for hay. Potatoes, turnips, cauliflowers, onions, and flowers are grown in all latitudes in Finland. A red microscopic plant grows and multiplies on the snow of Akavare Mountain.

The northern birch forest grows in Dalarne, Lapland, at altitudes of fifteen hundred to three thousand feet. Heaths stretch upon the higher areas. A fine, flexible sedge is used

for lining the Lapp's boots. Wild berries serve as a basis for cordial. In Lapland, there are about ninety-nine kinds of dandelions along with an abundance of wild flowers such as butterballs and dwarf dogwood.

Animals

The reindeer is the important animal in the tundra section of Europe. Sixty thousand head of reindeer are raised, by the Laplanders, on the good grazing ground to the east of the main divide. In the winter, the reindeer is used for a draft animal to pull a sledge called a pulka. The male reindeer is used for a pack animal. In the fall, reindeer lose their antlers. Wherever reindeer are found, their enemy, the wolf, is present, too.

Reindeer skin is useful for boots, trousers, and tunics which are worn with the hair on the inside in winter and on the outside in summer. The skins are tanned by floating on a lake until the hair begins to slip. With the hair removed, the skin is rolled up with white birch inner bark and the tannin changes the raw skin to leather.

The Lapp dog is used as a herder. Its food is hot soup of reindeer blood.

The swamps, in summer, are swarming with mosquitoes and flies.

The Arctic lemming is an animal with peculiar habits. It was once believed that this animal migrates to the sea for food and that it goes on and on until it dies of some unknown infectious disease. An even later belief is that these creatures

have a strange sexual urge which forces them to go into the water where they finally drown.[142]

The Barents Sea abounds with many cod and herring. It is an important area for fishing activities. Finmarken, Norway, has less importance for cod fishing than the Lofoten Islands but the fish are dried and cod liver oil is made here.

Inhabitants

The Lapps of the Scandinavian Peninsula number twenty-five thousand. They have a short stature and are considered the shortest people in Europe. They inhabit the tundra and occasionally come into the forest region. They wander over the area from 62 degrees N latitude to the northern border. National boundaries mean nothing to them for they migrate freely between Norway and Sweden, Finland and Russia. In winter many of them live in the interior in permanent winter dwellings. In summer they move to the coast following the retreating snow in order that their herds may secure tender food and freedom from the mosquitoes.

The Lapps were a nomadic people back in the paleolithic age. Chipped stone implements, recently found in Finland and Norway, represent these early people who lived on a moraine now elevated to two hundred feet. Dwellings have also been uncovered.

Present day Lapps have a fair complexion, blue to brown

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142. TRAVEL, Magazine, May 1946.

eyes, and somewhat curly hair. Their heads are broad, their beards scanty, and their stolid, reliable personal characteristics seem of Mongolian ancestry even though their language is unrelated to that race.

Swedes probably forced the Lapps to migrate toward the interior. Now they have adapted themselves to the climate, physically. The Swedish people haven't urged them to conform to Swedish civilization. They have been encouraged to retain their culture and educational system.

The Gallivares and the Jokkmokk are the tribes to which the Lapps belong. The mountain Lapps are nomadic for they wander with their reindeer to the treeless western mountains or plateaus in summer and, in winter, they move east where the reindeer can find lichens and mosses. The graziers have herds of reindeer and spend their summers along the coast.

The Lapps earn their livelihood caring for dogs and reindeer in a primitive way. Their culture was that of the Stone Age until they traded with advanced peoples. Lapps frequently intermarry with the Finns. Finnish women rarely marry Lapps for Lapp men are considered worthless. Lapp women do most of the work.

The Lapp home is a kota which resembles an American Indian tepee. A lightweight woolen material serves as a tent cloth. Twigs are placed on the ground in piles eight to ten inches deep that serve as a soft, springy, and slippery flooring. Reindeer skins are used for chairs and beds. Birch bark cases

are used for storing and carrying articles. Lapps dress in coat-like garments trimmed with bright bands. Goat milk is used more than reindeer milk. Goats can live on very sparse pasturage, are more docile, and give more milk. Reindeer sinew is very strong and is used for thread. The meat is dried.

The wild berries, stems, and leaves of a few plants make up the vegetable diet. They also eat black spotted trout. Laplanders are great coffee drinkers. When they brew coffee, they put in a fish skin to settle the ground.

For a weapon, the Lapp uses the bow and arrow and cross-bow. His boats are thin and flexible. A Lapp's sledge is called a "pulea" and is made with a plant held together by sinew. Nails, in a cold climate with a great range of temperature, become loosened and are inferior to sinew fastenings.

The Lapps in Norway number about twenty thousand.[143] Vadso has eight thousand Finns, also. By the Swedish-Norwegian Treaty effective from 1923-1952, the Lapps are allowed to graze reindeer on Norwegian soil. The northern coastal region is quite densely populated. The two most important settlements in the north are Tromso, and Hammerfest (population 3,646), the world's most northern city. Kirkeness has a population of five thousand. The northern Scandinavian Highlands are uninhabited except in the extreme north. The southern mountains were a former hunting ground for reindeer.

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143. THE GEOGRAPHY OF EUROPE by George D. Hubbard.

In Sweden, there are seven thousand Lapps scattered widely in the northern states. The altitude, relief, and climate keep the population limited. Swedish Lapland is in the Kilpisjarvi section.

The dwellings of the Swedish Lapps are portable tents which have a light, removable wooden frame of poles. A thick sacking cloth is stretched over the frame. Fires, in the tent, are put out at night to prevent burns from flying sparks so the Lapps sleep fully clothed. They build sheds and storehouses.

Forest Lapps live in wooden houses. For transportation, the Lapp of Sweden uses a one-runner reindeer sledge that looks like a boat. A Lapp also travels on snowshoes.

The iron ore district of Sweden has a sparse population. Kiruna had 10,285; Boden, 6,594; and Porjus, 1,022.

The Finnish Lapponic population of 2,113 in 1930, was divided into four colonies; one in the far north and three in or near the Arctic Circle. At Uleaburg, in northern Finland, the population numbers five to the square mile. Lapps in Arctic Finland are nomadic and wander between Norway and Finland. The three main groups of Lapps are the Sedentary Lapp, on Hellenfjord, who lives by fishing, and the Mountain and Forest Lapp who have settled down with their reindeer herds.

The original inhabitants of the Petsamo region were Skolts who were close relatives of the migratory Lapps although they, themselves, were not migratory. The name Petsamo is of Lapp origin.

Minerals

Iron ore in the form of magnetite is mined from open quarries near Kirkeness in the extreme northeast corner on Varanger Fiord, Norway. Magnetite iron is crushed and oxidized into hematite. By magnetical separation, the hematite is pressed into briquets for exportation. Iron pyrites are exported from the mountains of northern Norway.

The Kiruna district of Sweden is one of the world's greatest sources of iron. Kiruna is located one hundred miles north of the Arctic Circle. This high grade iron ore occurs in thick veins in an open pit. The cold freezes the ore into solid blocks. Iron was first mined and shipped from here for smelting about 1900. Strip mining is possible because the high quality ore is near the surface. Sweden ranks third, in Europe, for the amount of iron mined. Sweden is practically the only country that produces charcoal iron. The steel from the ore is of unusual high quality. The electric railway which speeds the transportation of iron ore is one of the most northern in the world and it is the result of engineering skill. The vast amount of water power supplies the electricity for the iron mines and railroad. Lulea, icebound for one-half year, is the Swedish port for exportation of iron. Narvik, Norway, is the ice-free port through which other iron ore is also exported.

The enormous reserve of Sweden's iron ore is rich, abundant, and clean. The iron ore district of Sweden lies between the northern border of Sweden and the Arctic Circle.

Kiruna, Malmberget, and Gallivare ship vast amounts to Germany, Great Britain, and the United States. About eighty per cent of the ore is exported. The Swedish government restricts exports and has scheduled certain amounts to various countries.

Good iron ore is also found in northwest Finland. Gold is found along the Ivalo River in northern Finland. The Petsamo region has nickel and copper deposits. Norilsk supplied minerals for both World Wars. Deposits of galena and sulphide of zinc occur along the coastal area. In 1938, due to mining activities, the population of the Petsamo region was 4,288.

Soviet Union Tundra

Topography

The topography of the Soviet Union tundra is that of one of the least known parts of the earth's surface. This tundra area forms the borderlands along the Arctic coast, and inland, it lies in the valleys of higher elevations. East of the Ural Mountains an ice free area is found. Here the ground is permanently frozen and there is the difference from ice layers below a layer of earth which is adjacent to the permanently frozen ground.

Since the tundra of the Soviet Union is fairly level from the Baltic Sea to the Lena River, it can be considered a plain. This plain, as a whole, has slightly uplifted sides and is stable.

Nearly one half of the Arctic lands lie in the Soviet

Union. In Siberia the Arctic zone occupies two-fifths of the territory. The width of the tundra belt varies from twenty to two hundred fifty miles. It has plains, mountains, rivers, deltas, snow, and ice.

The northern plains of the Soviet Union were never permanently glaciated. The streams flow north due to the glacier.

In the summer the soil produces flowers but in the winter dynamite is used to break it. The soils of the tundra are immature because they are frozen and have a limited drainage. The decaying vegetation over mineral soil is acid.

The Soviet Union has four rivers which flow north. Three of these rivers are in Siberia and are considered the largest that flow north in the world. They are the Pechora, the Ob, the Yenisei (which is the great river), and the Lean with its thousand tributaries. These rivers form the network of the east-west highways.

Throughout the tundra are widespread lakes and swamps which make travel difficult in summer. The frozen sub-soil prevents ground water drainage. Since there is such poor drainage a wonderful breeding place for mosquitoes is found.

Due to the vast size of the Soviet Union, its tundra area is inaccessible. The western section of the tundra borders Finland and extends eastward to the northern Ural Mountains. This area includes the Kola Peninsula, the northern finger of the White Sea, and the Pechora Triangle. The Kola Peninsula, sometimes referred to as Korelia, belongs to the glaciated

Baltic Shield. The western and central sections are divided by the Northern Ural Mountains. The central section lies east of the Ural Mountains and includes the basins of the Ob, the northern Yenisei River, and the northern Lena River. In the central section lies the North Siberian Plain. The eastern part of the Soviet Union lies to the east of the Lean River. It includes the Stanovoi Mountains, the Verkhoyansk Mountains, the Kolma Mountains, the Anadyr Mountains, and the mountains of the maritime provinces in the eastern part of Siberia. Kamchatka and Chukchi Peninsulas are in the eastern section. Much is yet to be investigated regarding the ridges and the geology of the Chukchi Peninsula. The western tundra of Asiatic Siberia is moist and flat whereas the eastern tundra is semi-arid to completely dry in the Taimyr and Chukchi Peninsulas.

The Arctic fringe has a part of the North Russian Plain in the Kola Peninsula and the Pechora Triangle. Near the Kola Peninsual and north of the White Sea region the Arctic coast has broad banks. The Timan Ridge, west of the Pechora River, has low cliffs on its western side. To the east of the Pechora River the coast is flat. From the Arctic coast the treeless tundra extends in a band fifty to one hundred fifty miles wide from Finland to the Ural Mountains. The tundra is twice as wide east of the White Sea that divides it, as it is west of it. The Pechora delta also nearly divides it.

The topography is monotonous. Along the shoreline there are dunes, beaches, sand bars, off-shore islands, and low,

rocky headlands at both entrances to the Cheshskaya Bay. The soils and flora are always frozen below the surface.

This tundra area is about five hundred feet above sea level except for the base level of the Timan Mountains west of the Pechora River. To the east of the Pechora River, as far as the Ural Mountains, the land is rougher than west of the Timan Mountains. In geologic age the surface of this region is recent. The tundra has a drift and moraine surface and the hills have higher growth in vegetation on the southern slopes protected from the wind and receiving a greater benefit of the sun. These hills furnish forage for reindeer and white fox.

The Pechora Triangle is dominated by the Pechora River. In the rolling areas, the higher land is well drained by streams which erode slowly but leave much marshy and boggy land in the depressions. The many tributaries of the Pechora River empty into the lagoon-like bay by a tangled delta which is broad, muddy, and not navigable. Its distributaries are constantly shifting. The mouth of the river is ice free one third of the year. There are no large rivers in the tundra belt west of the Pechora River in the Soviet Union. The Pechora lowlands are underlain by coal and oil. Along the lower Pechora River, the area is low, flat, damp, and mossy.

The Tuloma River, flowing from a lake in the western part of the Kola Peninsula to Kola Bay, provides the only water power in this section of the Soviet Union. It furnishes light and power for the homes and machine shops of Murmansk. Murmansk is almost isolated because of its distance from

greater centers. Alexandrovsk, on Kola Bay, is never frozen. A railroad connects this port with Leningrad.

The arm of the White Sea which lies in the tundra adjoins the Arctic and is not more than thirty miles across. For nine months this entrance to the White Sea is closed by ice and the east side is never open.

Eastward from the Pechora Triangle lies one of the three divisions of the Ural Mountain system. The section is called the Northern Ural Mountains and extends from 61 degrees N latitude exactly north to 65 degrees N latitude where it bears northeast to 68 degrees N latitude. Here the mountains turn almost at right angles and continue northwest in the Pai Khoi range on Kanin Peninsula, Vaigach Island, and Novaya Zemlya. Northward from the Arctic Circle the Ural Mountains are called the Samoyed Urals and remain uninhabited. The Ural Mountains have an average altitude of two to three thousand feet. In the Samoyed Urals, the main ridge is 1,640 feet above sea level with individual elevations of 3,800 feet. The highest point in the Northern Ural Mountains is 6,202 feet. Mount Tel-Posis has an altitude of 5,500 feet. The smooth surfaces on the mountains tell that they were once glaciated. Today one glacier remains. Due to the general low elevation, these mountains are no longer a barrier. In the Samoyed Urals, the mountain foot is stony tundra dotted with lakes and swamps which are sometimes damp and sometimes dry. Deciduous forests grow almost as far north as 68 degrees N latitude especially on the eastern slopes.

The Pechora and Ob Rivers are used as waterways for travel and transportation by the Samoyeds, Zyrians, and Ostyaks who wander and live here with their reindeer herds.

Almost at right angles to the Ural Mountains is the low plateau-like ridge of Pai Khoi. The Kara River valley, between the Northern Ural Mountains and Pai Khoi, crosses the hilly tundra to the Kara Sea. It serves as a good reindeer pasture.

Vaigach Island lies between the Kanin Peninsula and Novaya Zemlya. Since it has risen from the sea it has a recent geology and has a tundra of uniformly low relief which is the continuation of the folded axis of Pai Khoi. The lowlands have recent marine sediments with lakes. Slate and limestone compose the lower ridges. A visible recent uplift is shown by the influence of floating ice. This rectangular shaped island is separated from the mainland by Yugor Strait and, from Novaya Zemlya, by the milder Kara Sea which cannot be crossed on sledges in winter. Ice storms and fog make plant life sparse. Woody growths are very meager and lichens have taken the place of mosses. Luxuriant flora on the island is found on the western side in the form of grasses, mosses, rushes, and willows two feet high. Geese and swans migrate to this island for the summer. Three species of fresh water mussels are gathered. The Samoyeds come to the island to hunt for fur animals but they have no permanent habitation. Its rivers and estuaries are places for fishing, sealing, and whaling. Mosquitoes are also present.

The tundra zone of the Soviet Union increases in width from the Ural Mountains to the Taimyr Peninsula and decreases from there to the eastward. The tundra limit lies farther south and widens the Arctic zone. The area of the tundra east of the Ural Mountains is approximately 1,270,000 square miles. Rivers cut through the tundra and carry uprooted trees in their currents. The West Siberian Lowland, east of the Ural Mountains, extends over the Yamal and Gydanski Peninsulas to the Yenisei River. This lowland area is drained by the Ob River. The flatness of western Siberia is due to a proglacial lake which was the largest fresh water lake ever known. It was larger than Lake Agassiz.

The Yamal, or Samoyed, Peninsula lies in a north-south direction. The Ob River has built up its sandy surface which has recently uplifted from the sea. The peninsula has a tundra cover and, where there is no tundra, sand dunes are present. A low divide runs lengthwise of the peninsula with brooks flowing down both sides. The west coast is relatively free from ice. The northern third of the peninsula is lower. In the interior are shallow seas which are entered by the white whales and seals from the Arctic Ocean.

> "The whole of the Yamal is a single great plain, made up of sand, clay, gravel, and pebbles. Along the shore it falls in a steep slope, that may be 60 to 90 feet high, but inland it is one low, undulating plain covered with grass and moss, with osier thickets here and there, and with a multitude of lakes great and small, and shallow rivers and brooks. There is excellent pasture for reindeer on these wide prairies, and the Samoyedes travel all through the summer with their herds of reindeer over the

whole country."*

The peninsula which lies between the estuaries of the Ob and Taz Rivers has no name. The Gydanski Peninsula is situated between the Taz and Yenisei Rivers. This peninsula has a structure and surface cover similar to the Yamal Peninsula except that its coasts are higher.

The Ob River has a broad estuary with sand bars. Salekhard is the chief port on the Ob River.

In Taimyr Peninsual, the lowlands are higher. The interior of this peninsula was revealed by Middendorff in 1843. Taimyr Peninsula has a broad front and Cape Chelyuskin is the northernmost point of the continent at 77 degrees 43 minutes N latitude. Here there are a variety of land forms. The two northward flowing rivers, the Taimyr and the Pyasina, divide this large peninsula into three parts. The Byrranga Ridge serves as the backbone and is cut by the two rivers. This highland rises to almost a thousand feet. The ridge is a folded zone. To the north and south of the ridge are moraines. Along the front is a steep coast faced with a flat shore and many skerries. The flat shore, with its driftwood that is particularly valuable to the Samoyedes, is slowly rising. The ground of the Taimyr Peninsula is drier because the elevation of the lands allows a quicker run off. Rock tundra is present on the north side of the ridge. South of the Taimyr Peninsula is the Khatanga Plain.

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*THROUGH SIBERIA THE LAND OF THE FUTURE by Fridtjof Nansen and translated by Arthur G. Chater, p. 24, Frederick A. Stokes Co., N.Y. 1914.

The Yenisei River flows in a northerly direction from the Aldan Shield to the Patom Plateau across the western part of the Khatanga Plain to the Arctic Ocean and lies in the same latitude as the Mackenzie River of Canada.

> "What a huge, broad mass of water flows out into the Arctic Ocean here; it makes a powerful impression. It gives one the feeling of being at the entrance to one of the greatest water arteries of the world."*

The Yenisei River is the fifth longest river in the world. Its length is three thousand miles. As it is the drainage basin for 970,000 square miles it ranks seventh in size of river basins of the world. The tributary, Angara, comes from the world's deepest lake, Baikal. All of the greatest tributaries to the Yenisei River come from the east. From Yeniseisk to the Arctic Ocean it has widths varying from one to thirty miles. The west side of the Yenisei River is steeper than that of the east which has sand banks, mud banks, and low islands. The deepest channel is on the eastern side of the river.

> "There can be no doubt that this is an effect of the earth's rotation, which causes all the water flowing in a horizontal direction to go to the right in the northern hemisphere...and this tendency becomes stronger the farther north we go."** (p. 72)

In the spring, the floods covering the east bank leave a fertile coating of mud for the growth of meadow grass and

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* THROUGH SIBERIA THE LAND OF THE FUTURE by Fridtjof Nansen and translated by Arthur G. Chater, p. 70, Frederick A. Stokes Co., N.Y. 1914.

** THROUGH SIBERIA THE LAND OF THE FUTURE by Fridtjof Nansen and translated by Arthur G. Chater, p. 69, Frederick A. Stokes Co., N.Y. 1914.

willow bushes. Oases of higher vegetation could feed many herds. The floods transplant the more southerly plants such as foxglove. The broad estuary of the Yenisei River is dotted with sandbars.

Igarka is the transshipment port on the Yenisei. The land at the mouth of the river has the appearance of a typical coastal platform.

> "These rocky knolls that stand up on the shore may some of them been islands, holms, and skerries, the space between them having since been filled up with the river gravel, sand, and clay. Then the sea has receded and the whole coast has become the inconceivably vast flat land that we now see."*

Political exiles of the Soviet Union are sent to the Yenisei region in the tundra.

The plains to the west of the Yenisei River change, in the east, to a broken, hilly, mountainous country receiving the name of Central Siberian Uplands. The Uplands have the Anabar Shield which lies between the mouths of the Yenisei and Lena Rivers. Here are found coal beds and a widespread lava flow.

The coastal belt between the Taimyr and Chukchi Peninsulas borders on the Laptev Sea. This belt is divided into almost equal parts by the Lena delta. The tundra region, classified as "dry", is along the coast from the Khatanga estuary to the apex of the Lena delta. The level surface of this area has an elevation of 330 feet interrupted by rock ridges. The coast and foreshore is steep.

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* THROUGH SIBERIA THE LAND OF THE FUTURE by Fridtjof Nansen and translated by Arthur G. Chater, p. 69, Frederick A. Stokes Co., N.Y. 1914.

The Lena River is almost in the middle of the Arctic Siberian coast. East of the Lena River to the Sea of Okhotsk are high rugged mountains. Along the steep Arctic coast, east of the Lena River to the Chukchi Peninsula, the elevation is slight, the foreshore is sandy, and the coastal waters are shallow. This coast is interrupted by deltas of the coastal rivers. Directly east of the Lena River are two bays, the Borkhaya and the Yana, separated from each other by Cape Borkhaya. Farther east are the Indigirka and Kolyma Rivers. The coast off the Kolyma River is of the ria type whereas the interior has elevations of considerable height because the Verkhoyansk Mountains reach the coast. This coastal area has many small lakes and short rivers and dry type tundra. East of the Kolyma River, there is mountainous tundra. The drainage and soils differentiate it from the coastal tundra.

The Chukchi Peninsula begins at Chaun Bay. Semen[144] circumnavigated this peninsula in 1648 but his discovery remained unknown for some time. The Great Northern Expedition made a complete survey and scientific report about the coast of the Chukchi Peninsula in 1734-1743. From Chaun Bay the coastline is fairly straight and has a low sandy shore that rises to a hilly tundra. The interior of the peninsula is mountainous for it is crossed lengthwise by parallel ridges. The highest

144. THE GEOGRAPHY OF THE POLAR REGIONS by Otto Nordenskjold and Ludwig Mecking.

elevation is Mount Matachingai with an altitude of nine thousand feet and situated on the Bering Sea side of the Anadyr Gulf. The valleys between the mountains are swampy and filled with lakes. Snowdrifts remain the year around where there is protection. The Cossack, Deshnev,[145] was the first to reach the most eastern point of the Soviet Union.

The Cherski Range, which serves as the source of the Indigirka and Kolyma Rivers, lies in the northeast section of Siberia. It was discovered in 1926 and has an elevation of 9,843 feet. A new road has been built from the source of the Kolyma River across the Cherski Range to Magadan on the Sea of Okhotsk.

Climate

Winter dominates the Soviet Union tundra. In the Siberian Arctic there are approximately only sixty frost-free days. The sub-soil is permanently frozen. The winter season is long, dark, and cold. The long period of darkness and the short period of light causes nervous disorders and breeds melancholy. Dry winter air causes the light snowfall to blow into drifts that keep the area snowcovered for eight or nine months of the year.

Temperatures along the coast of the Soviet Union are warmer than they are inland. Sagastyr, on the Arctic coast, is about twenty-five degrees warmer than Verkhoyansk because of the absence of temperature inversion over the flat tundra.

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145. SIBERIA by Emil Lengyel.

Radiation causes the air to drain or flow into the valleys and makes the cold more intense in the inland mountain area of eastern Siberia. East of the Ural Mountains, the mean temperature for January usually goes below zero. The air is bracing and calm. Vegetation, for the most part, is dormant. Sunshine is so warm it melts the snow on the roofs. The spring season is usually cooler than the autumn. In the interior, warm weather comes faster because there is little snow to melt, there are no large bodies of water to give marine influence, and the air is less humid. In the summer, the coasts are cooler than the interior. During this season the polar fronts move north and bring greater temperature differences to the coasts than they had during the winter. The polar continental air mass over the Soviet Union develops from air previously marine in character and therefore it is warmer and moister. In summer the daylight hours are short but usually bright.

"The sun blinds badly. One's eyes begin to weep, sharp pain follows. It passes off in time, but still it does harm to the sight permanently."*

Pressure conditions over the Soviet Union are high caused by the wind divide along 50 degrees N latitude. North of the wind divide the prevailing winds are from the south and west. These pressure conditions last for a nine month period. Winter in Siberia has extreme conditions of -40 degrees

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* THE VOYAGE OF THE CHELYUSKIN BY MEMBERS OF THE EXPEDITION, translated by Alec Brown, p. 310, MacMillan Co.,N.Y.1935

Fahrenheit caused by winds blowing in from the sub-arctic region. These winds blow from the south or southeast. The properties of the polar continental winter air mass which originates in Siberia and Outer Mongolia are intense cold and dryness. This air mass moves over the Pacific Ocean where it changes to Polar Pacific. Winds from the North Atlantic bring the winter cyclones to the Soviet Union. There is danger, during the cold period, from winds which sweep up snow from the ground. In the summer the North Atlantic brings a low pressure area over the Soviet Union. The cold winds blow from the north or northeast in this season. In the northern and central section of western Soviet Union, the winds are northwesterly and westerly whereas, in northern Siberia and eastward, the winds are more easterly. The eastern part of the Soviet Union has a continental climate with a monsoon tendency. Cyclonic storms move across northern Asia from a westward position in all seasons. West of the Ob River, the winds belong to the Icelandic low. West and central Siberia receive exceedingly cold southerly winds. The monsoon type wind characterizes the whole of the Asiastic Arctic zone. In winter the winds blow off the land and in summer cool winds blow in from the sea. All along the Arctic there are stretches of open water in winter. Wind blowing across these open places bring needle-like frozen vapor called "frost smoke". In the summer the winds are sometimes so cool that they destroy vegetation. A suggestion has been made that the wind be utilized for power.

Precipitation throughout the Soviet Union diminishes

regularly from northwest to southeast. Most of the precipitation falls in the summer and autumn. The amount of Atlantic moisture which falls in the tundra of the Soviet Union varies from eight to ten inches. Inland areas have less than coastal. The summer months bring the heaviest rain. Most of the distant Atlantic moisture is robbed from the clouds in Scandinavia and the Ural Mountains. There is abundant rain and snow over the mountains. The Arctic winds give little precipitation because they are cold and blow over warmer land. Snow does not always fall in Siberia but there is usually a snow cover from November to April. Terrifying snowstorms called "purgas" sometimes rage over this area of the Arctic. These blizzards block communication and hinder construction.

Rivers and coasts are frozen from 160 to 280 days. Ice forms on the rivers to considerable thickness and many of them freeze solid. Water along the north coast freezes about the middle of October and opens about the middle of May. The northern coast of the western part of the Soviet Union is the least ice bound. The port of Archangel is closed by ice for about 190 days. The north coast of the central and eastern section of the Soviet Union is ice bound for most of the year. Permanent Arctic Ocean ice almost reaches Novaya Zemlya, Taimyr Peninsula, and the New Siberian Archipeligo. The Yenisei River has ice thirty feet thick and the Indigirka River has ice seventy feet thick. The winter temperature at the mouth of the Lena River is warmer but the winds make it no more agreeable than the cold of Verkhoyansk. In the summer

the cool wind keeps the mosquitoes away. Sometimes the cold (a nyalod) is so intense that ice turns to water instead of water turning into ice. When water turns into ice it expands. The expanding displaces water to the surface which gives the impression of sweating. The perspiration turns to ice.

The Aurora Borealis brings beauty to the long period of darkness in the tundra.

The Polar maritime climate of Asia originates over the Sea of Okhotsk and brings a gloomy, drizzly weather. In summer the Sea has floating ice and fog. The precipitation of drizzle and mist amounts to about seven inches a year. In summer the maritime climate of the Sea of Okhotsk penetrates inland to the northeastern mountains of Siberia and makes them cloudy and foggy.

When traveling in the tundra, the natives of the Soviet Union keep the runners of the sledges iced. For this purpose a bottle is filled with snow and placed next to the skin of the traveler. In this manner the snow is thawed and ready to use.

The cold makes it very difficult to start engines. Weather observation posts have been set up throughout the tundra and, by the use of airplanes and radios, keep in touch with the outside world. These stations record Arctic weather conditions.

Polar Atlantic climatic conditions prevail in the tundra region of the northwest section of the Soviet Union. They usually show mild instability and convective activity. The

tundra in this section lies in a higher latitude. Polar weather effects the White Sea area and the Kola and Kanin Peninsulas. The ground around the White Sea is not permanently frozen. There are wide seasonal variations throughout this northwest area due to the variability of the Polar Atlantic front. Archangel has an average annual temperature of 33 degrees Fahrenheit and an absolute temperature of -46 degrees Fahrenheit is experienced in the eastern portion near the Ural Mountains. Along the Arctic fringe of the Kola and Kanin Peninsulas, the greater part of every month is cloudy and misty. The open North Atlantic on one side, agitated by the Gulf Stream, and the White Sea on the southern side are the cause of the clouds and mists. Most of the rain falls in the autumn. Snow on the Kola Peninsula is deeper and longer lasting. The twelve to sixteen inches of snow stay 200 to 225 days. The total yearly precipitation ranges from fifteen to twenty inches. The humidity is fifty-six to seventy per cent.

The Polar Continental air mass has its source region in the northwestern section of the Soviet Union and in northern Fenno Scandia. The polar continental air mass is more frequent in the Soviet Union. The winter climate of the remaining Soviet Union tundra is effected by the west winds in the source region of the western tundra section. Throughout this tundra area the summers vary from warm to hot and violent storms are frequent.

The precipitation in the Northern Ural Mountains never varies. In the summer the mountains cast a rain shadow in the

Ob River valley.

Taimyr Peninsula and Gyda Bay, west of the mouth of the Yenisei River at 72½ degrees N latitude, have a July temperature below freezing. Some of the temperatures do run to 50 degrees Fahrenheit. In this respect it resembles the American Arctic Archipeligo. Snow comes in purgas or severe blizzards. In winter the winds are dry over this peninsula.

The mean summer temperature on the coastal belt between the Taimyr and Chukchi Peninsulas is 1 degree Fahrenheit, the lowest for that belt. Winter cold is milder near the coast and the summer temperature is reduced by the sea.

> "In the cold breathing becomes painful; and the exhaled vapor crystallizes to crackling needles of ice. Parties on the march are enveloped in a thick cloud of fog. Ice forms in the nostrils of horses and threatens to suffocate them."*

On the Chukchi Peninsula, in the protected places of the mountain valleys, snow remains the year around. Summer is not felt until July and, in August, winter sets in again.

The high promontory of Sieveroi Vostochnoinos has the only perpetual snow in the Soviet Union.

The seasons are intensified in the eastern part of the Soviet Union because the wide expanse of land gradually nullifies the maritime effects of the Atlantic Ocean and causes continued low temperatures.

Vegetation

The vegetation belt of the Soviet tundra varies in width

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* THE GEOGRAPHY OF THE POLAR REGIONS by Otto Nordenskjold and Ludwig Mecking, p. 174.

from thirty to two hundred fifty miles. The southern limitation is based upon the 50 degrees Fahrenheit isotherm for a July mean. In the Soviet Union, the tundra is divided into Arctic tundra, Bush tundra, and South tundra. In the Arctic tundra are numerous carpets of lichens and mosses. Mosses often attain thicknesses of five feet in low areas. Lichens grow in the dried areas. In the Bush tundra grow dwarfed birch and willow, lichens, and mosses. The South tundra has low stunted fir, birch, and larch trees. They grow about one foot high and their long branches spread flat along the ground. The dwarfed trees are surrounded by mosses which form sphagum peat bogs. Often the trees are partially covered by mosses, lichens, and heaths in a tangle. The plant growing season is less than three months. During this period the vegetation flowers and bears edible berries similar to our blueberry and huckleberry. This perennial vegetation is spread on the ground for maximum insolation. Higher growth in vegetation occurs especially on hills having a southern exposure where they are protected from the wind and receive a greater benefit from the sun. Tundra vegetation grows in waterlogged soil which is frozen many feet deep in winter and thaws a foot or two in summer. Flowers and grasses come to life suddenly in summer and prosper in the thin layers of soil.

The Soviet Union has established agricultural research stations in the tundra area for experimental purposes.

Fir trees determine the southern margin in the tundra of the far western part of the Soviet Union. Along this border,

the chief industry is fur trading. Peat is the richest resource of this tundra area. Some of it is found on the Kola Peninsula where considerable amounts are in the areas east of the White Sea. There are an estimated twelve to twenty-five tons of peat to each square mile. As yet there is no great use for it and the region remains one of low subsistence and meager opportunity. Among the shallow rooted plants which survive here are grasses, sedges, perennial herbs, numerous bulbs of which the daffodil is one, violets, marguerites, forget-me-nots, and bushes of heath, azalea, and arbutus. Most of this vegetation has its best growth in the more sheltered places. Away from protection against wind, there are dwarfed birches and willows a few inches tall which generally creep along the ground. Agriculture has been unfavorable at Murmansk.

The Northern Ural Mountains have some mountain tundra.

The tundra of the Ob River region is moist and flat with its "quaking bogs" where moss is becoming peat. The meadows are bordered with reed and cotton grasses. The trees throughout the Arctic Siberian tundra are deciduous. The nomad tribes use the willows for fuel even though they are dwarfed and not more than three feet high. Berry shrubs are also present in this whole section.

Plant life in the Samoyed and Gydanski Peninsulas is similar and includes willows and some birches which become more scant in the north. More trees grow toward the centers of the peninsulas where there is grass, also. In the southern portion

are growths of alder and fir.

Inland along the Yenisei River, the plain is covered with grass and swamp. Alder and scrub bushes grow as high as one's chest. In the spring this whole section is inundated because of the annual flood. Larch is the northernmost tree of the Yenisei plain and, on the southern portion, are larch and spruce. On dickson Island in the Yenisei River, experimental gardens and greenhouses have been built. Electricity, to operate the underground greenhouses, is generated by the wind and provides the necessary light and heat. Mushrooms, cucumbers, lettuce, and varieties of fruit are grown in the hothouses. Chinese cabbage has been grown successfully. Girls carry out these agricultural experiments.

On the dry tundra of the Taimyr Peninsula, there are mosses, reindeer lichens, and creeping willows. Spots of rocky, sandy, and gravelly soil are bare. The moss patches are dirty yellow-brown and the lichens are gray. Depressions have a grass cover, herbs, berries, and woody bushes. The forest extends northward in the southeast section at the mouth of the Khatanga River. This northernmost forest of the earth is composed of larches.

Between the Lena River and the Chukchi Peninsula, the tundra is dry. In depressions there is a moist tundra or deciduous forest. It is called the mountian forest tundra. In the southern part of the Lena River delta, the forest begins. To the north of the forest, on the delta, there are

about four hundred species of sub-arctic flora. To the east of the Lena River, mountain tundra replaces the gaiga forest.

Tundra growth covers large areas on the Chukchi Peninsula In places there are meadows of dense grass and gray and white lichens. Two hundred twenty varieties of flowering plants grow on the peninsula. Among them are cotton grass and Chukchi primrose.

Animals

Today, the most important animal of the Soviet Union's tundra area is the reindeer. This animal has been tamed by the various tribes and used for transportation, food, clothing, and shelter. Reindeer migrate from forest to the cool coasts in the spring and live on the good tundra vegetation as they go. These animals have hoof and mouth disease, though.

Foxes are the most valuable fur bearing animals trapped. The Arctic, or ice, and land fox are the two types of white foxes. The Arctic fox eats mice and the remains of seals left by the bears. Mice, in droves, venture onto the ice packs. The land fox is larger than the Arctic fox and eats mice or forages on good vegetation. It lives in a den and has coarser fur. Occasionally red and blue foxes are trapped. The silver fox is rare. Other tundra animals are the polar bear, the not-too-plentiful wolf, and the lemming. Carniverous animals move north in the summer after wading birds.

The vast mammoth cemeteries show that this animal had coarse hair and a layer of soft brown wool which seems to indicate that Siberia's climate must have been as cold as it is now. The mammoth had small eyes and ears and tusks that were gnarled and twisted - an indication that they were used

for breaking ice to get moss and water. These tusks furnish an ivory supply. The tribes of eastern Siberia traded in tusks with the Chinese as early as 400 B.C. The stomach contents of these huge animals proves that the fauna was the same four hundred years ago as it is today. Sometimes the rotting carcass of a mammoth has been used for food. Not only has the frozen mammoth been found, but also horses related to today's wild horse of Asia, a giant ox, woolly rhinoceroses, a kind of tiger, the musk ox, and the reindeer.

In summer the swamps are filled with swarms of mosquitoes and flies. These stinging pests make life miserable for man and animals. The cool coastal areas of the Arctic fringe give relief from these insects.

Summer calls the birds back to the tundra coast. Ducks, gulls, and other migratory fowl gather here. Many of the birds are killed for their feathers, down, eggs, and the fertilizer that is sold in the market.

River water and the Arctic Sea abound with salmon, cod, strugeon, and herring. People of the tundra find fishing a good occupation.

A few wild fur bearing animals live the year around in the tundra section of the Kola Peninsula to the Pechora River.

In the Siberian tundra, the lemming and the Arctic fox are the chief animals. Reindeer live along the southern border. The ptarmigan and snowy owl are the principal birds. Along the coastal margins and on the islands, there are polar bears. Sea animals are few but mosquitoes are present in unimaginable

numbers.

Birds and mammals are more numerous in the southern section of the Samoyed and Gydanski Peninsulas. The hare is only in the south and the polar bear only in the north. The central and southern areas are used for reindeer pastures by the Samoyedes. Fish are plentiful in the lakes during the summer. When spring comes, the polar bear and the seal move northward.

The Yenisei River carries quantities of plankton in the summer. Therefore, fisheries are situated on the river. Sturgeon, nyelma, amul, muksun, and seld use the upper Yenisei as a spring spawning place. Most fish are caught at this time by the use of the seine. Along the Yenisei River and throughout its vast plain are found evidences of the mammoth and the rhinosceros.

> "It is one of the most extraordinary and puzzling things though, that we meet with here in this country, so remarkable in so many ways: this question of the large extinct animals, usually the mammoth, but sometimes also the woolly rhinosceros, that lie practically intact, with bones, flesh, skin and hair, inclosed in the eternally frozen soil."*

Between the Taimyr and Chukchi Peninsulas, along the coastal belt, there is quiet during July for there are no birds.

Fish and whales are caught along the coast and up the rivers from the Lena River to the east.

The most famous discovery of the mammoth was made in 1900 on the Bresovka River, a tributary of the Kolyma River.

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* THROUGH SIBERIA THE LAND OF THE FUTURE by Fridtjof Nansen translated by Arthur G. Chater, p. 119, Frederick A. Stokes Co., N.Y. 1914.

"The mammoth had thawed out of a steep bank of frozen muck and rolled down an incline. Wolves and other present day animals had eaten much of the skin and flesh from the head and back, and most of the internal organs were missing, but the rest, when freed from the frozen earth, was found to be in almost perfect state of preservation. The fat was still white and fresh, and the meat was red and soft when completely thawed. Most of the fur became detached with the surrounding earth, but the limbs were extricated intact with nails and hair. The tail was perfectly preserved. Other less perfect specimens have been found, and from them practically every part of the animals's body has now been recovered - eyeballs, ears, trunk, stomach and even the navel."*

North of the Sea of Okhotsk, there are white foxes, wolves, wolverines, deer, brown and polar bears, ermine, squirrels, and hair seals. Ivory, whalebone, and furs are items of trade from this area.

Inhabitants

Throughout the tundra of the Soviet Union there are several tribes belonging to the Mongolian. The people living there today are descendants of the Palaeo-Siberians or Palaeo-Asiatics. Tribes of the northeast are the Chukchiis, Koryaks, and Kamchadals. These northeastern tribes make their living by hunting, fishing, and reindeer breeding. The Yukaghirs and the Uenisei Ostyaks are some of the other northern tribes who are thought to be related with the Ainus of Japan, the Aleuts, and the Eskimos of North America. The Neo-Siberian tribes (about one million) settled in Siberia during the great movement. They are the Voguls, Yenisei Tungus, Ugrians, Yakuts of Lena Valley, Ostyaks, Dolgans, Samoyedes, Finno-Ugrians, and

* THE RIDDLE OF THE MAMMOTHS by Ivan T. Sanderson in THE SATURDAY EVENING POST, December 7, 1946, Vol. 219,No.23.

other allied tribes. Each of these tribes has its own language. Formerly, Nentsi was used to mean Samoyed and Evenki to mean Tungus. The names were changed because the tribes have been given an alphabet. Schools, medical centers, and reindeer breeding stations are provided for these people under the Five Year Plans of U.S.S.R.

The tribes of the tundra are referred to as nomads because they are wandering hunters and fishermen of the Arctic fringe. In the summer they fish from canoes along the streams and in winter they trap. Reindeer breeding is their mainstay of life. The nomadic tribes seek food and protection for their herds. They cover great distances, migrating north in summer and south in winter. Their summer dwellings are light tents; in winter they live in covered earth pits. If they are overtaken by a storm, they dig shelters in the snow.

The inhabitants are affected by the arctic hysteria which is traced to the rigorous climate. It is a mimicry mania which causes the person to make unusual sounds and to dance--sometimes until he is exhausted.

The Kola Peninsula area of the tundra of the Soviet Union is predominated by Russian inhabitants. The Lapps, Karelians, and Finns occupy the interior of this peninsula. The people in this area are of the Finno-Ugrian family who number 2,750,000. They live east and north of the forest in the following groups: the Mordves, Mari, Lapps, Permians, Zyrians, and Karelians.

The nomadic Lapps only number about one thousand in the Kola Peninsula. They have a backward, primitive culture and

make their living from the reindeer. Fifty head of reindeer keep a family of four or five and require four or five square miles for pasturage. The Lapps fish in the summer and remain sedentary in the winter.

In the Kola Peninsula in 1926, the birth rate exceeded the death rate two and half times. The population is concentrated on the coast and sparse in the interior. The census gives a tundra population of one, or less than one, per square mile. The people use peat for fuel. Literacy among most of the inhabitants of the Kola Peninsula is a bit above fifty per cent but, in rural areas, is not as high.

Fishing is the leading occupation and employs more people in the northwestern tundra area of the Soviet Union. Reindeer raising is the second important occupation. This work requires seasonal migrations.

In winter, the people of this tundra area do household occupations, some lumbering, and fish packing. In their homes, they manufacture leather, dress furs, make boots, prepare clothing, work hair for felting overshoes, and use bone and horn. The people trade in herring and leather products by using the railroad which connects this area with Leningrad.

The harbor at Murmansk is the gateway to the interior of the northwestern section of the Soviet Union. Because of the Atlantic drift and the fresh water, this harbor is open the year around. A railroad has been built to aid the shipping of goods from Leningrad to Murmansk and vice versa. According to the 1939 census, Murmansk had a population of 117,054. It is

the largest city within the Arctic Circle.

The total population in the Karelia region, in 1939, was 469,145--a density of 8.9 persons per square mile. In 1939, Murmansk had 117,054, Kandalaksha had 7,799, Manchegorsk had less than 25,000, Archangel had a possible 281,091, and Vorkuta, just west of the Northern Ural Mountains, had 25,000.

The Samoyedes have a sparse nomadic population of about seven thousand who live in a few settlements along the rivers. They roam the tundra from the White Sea eastward--caring for their reindeer, fishing, and hunting. They live by seasonal migrations, spending the summer near the coast away from the mosquitoes and the winters near the forest. The Russians predominate in the tundra east of the White Sea to the Timan Mountains. There are no permanent settlements or residents, therefore, there is a labor shortage for work in the peat bogs. The Zyrians live south of the Samoyedes in the forest.

Beyond the Timan Mountains, the Zyrians have the largest population. This Permian branch includes the Zyrians, the Permyak, and the Votyak. There are 875,000 in the upper Pechora and Kama River basins and between the Vyatka and Kama Rivers. These people show Oriental racial connections and cultural mores. They are not mixed with Russian blood. Along the Pechora River and at its delta there are from 25 to 50 inhabitants per square mile.

The Siberian tundra lies to the east of the Ural Mountains. Many Russian immigrants have gone to western Siberia because of the attractive fur trade. Many were exciled as criminals

who had a large following.

The only inhabitants of the Samoyed Peninsual are about one thousand Samoyedes (meaning "inhabitants of a swampy land") who tend one hundred thousand reindeer.

In the Yamal Peninsula there are ten different tribes of Samoyedes each having their own section of the peninsula. They fish in the lakes and catch geese within their own territory. The rich Samoyedes have as many as five thousand reindeer, two or three tents called "chums", and two or three wives. To the Samoyede, the price of a wife is from 30 to 100 reindeer. Samoyedes have an average intelligence. The Taimyr Peninsula is divided among the nomadic tribes. The pure Arctic Samoyedes use the western part of the peninsula for grazing reindeer herds, gathering berries and roots, and fishing. The Samoyedes spend the winter near the lower basin of the Ob River. In March and April, the Samoyedes return to the pastures in the north. The majority of them return to Yamal where the reindeer are safe from the mosquitoes. This journey takes about two months. All Samoyedes are primitive and their culture is declining for they are not in contact with European civilization. Their Samoyed languages differ yet they belong to the same linguistic stock. Their senses and faculties of hearing, seeing, accuracy, and running are well developed. Their sense of smell, taste, and feel are not so good. Reindeer meat is always eaten raw and it is a luxury to drink the blood warm. The Samoyedes take their furs to the fair at Salekhard in order to sell them and have currency with which to pay their taxes

to the Soviet government. Among the Samoyedes there are no written laws and no organized government. In the Samoyed religion there is belief in a Supreme Being and in some transmigration of the soul.

> "The Samoyeds admit the existence of a Supreme Being, creator of all things, eminently good and beneficent, but who takes no interest in the affairs of men, and requires no worship. They believe, however, in a very powerful evil being, from whom come all the misfortunes that befall them, yet neither do they worship him though they fear him greatly."*

The inhabitants of the Yenisei River section are the Yenisei-Samoyedes. Although they are not numerous, they have a wide distribution. Originally the Yenisei wandered, in search of food, from the Pamir Plateau west of Sinkiang, China, and blended with the Ugro-Samoyedes who migrated from the south. The latter were cannibalistic. The Ostyaks of the Yenisei region are of unknown origin. They look like American Indians. In the Gydanski Peninsula, along the Yenisei River, are many fishing villages. The Yenisei Yuraks are added to other tribes in this area.

Tungus tribes (hunters) live in the Yenisei valley and to the northeast. They have a communistic anarchy for they have no chief. The recognized authority among these tribes is called "the shaman".

Igarka, on the Yenisei River, is the best known Arctic city in Siberia. Ocean vessels of many countries go up the

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* THE POLAR REGIONS by Sir John Richardson, p. 338, Edinburgh, Adam and Charles Black, 1861.

river to the port. Although it is not representative of the entire north, it is a Soviet show town visited by many foreigners. The normal population is twelve thousand but, in summer, it increases to twenty thousand. Igarka is a center for the lumber industry. It has a suitable location for radio communication and transportation by the principal northern air route. This city represents a cultural center yet it is young and crude with unpaved streets, lack of sanitary plumbing, mosquitoes, and ramshackle cabins which house some of the population. The city has a curative climate for pulmonary diseases. Soil cultivation is practiced where marshes can be drained. The soil is not frozen under protective covering. State dairy and vegetable farms are maintained. A narrow gauge railroad connects the forest with the port. Some of the people living here are exiles and some are free.

Between the Lena and Indigirka Rivers, on the coastal belt, the people are mostly Yakuts. The Yakuts on the delta of the Lena River have no reindeer and no tents. The Yurts are made of driftwood and are scattered, in large numbers, over the area used for hunting. Bulun serves as a trading center for furs and tusks. The chief port in this area is Tiksi, on Tiksi Bay east of the Lena delta. Fishing villages along the eastern bank of the Lena River make the whole area less isolated than the open tundra of the west.

From the Indigirka River to Cahunskaya Bay are the Yukagirs. These people are less filthy than the Chukchiis.

They have no watches but tell time by a primitive calendar which has holes and pegs similar to our cribbage board.

The Chukchiis, pure Arctic nomads, dwell on the far eastern Chukchi Peninsula. Their bodies are tall and angular with a characteristic high cheek bone. When the Russians swept across the country, this tribe was very resistant. They are very proud and, therefore, have refused to trade directly with the Russians until quite recently. The Ankalin, or coastal inhabitants, and the Chowchus, or inland dwellers, make up the two groups of Chukchiis. The Ankalins number about three thousand. They fish and club seals. Some Eskimos liveamong the coastal Chukchiis. The Coastal Chukchiis live on sea mammals. Their houses are made of skins stretched over pole frames. These people live more civilized lives and keep their own mode of life. They are learning to read and write. Inland Chukchiis have a population of ten thousand and are found as far east as Chaun Bay. Even with the coastal dwellers the Chukchi Peninsula has a sparse population. The Chowchus make their livelihood mainly by herding reindeer, but they participate in fishing and hunting, too. They seem to crave a vegetable diet. When a Chukchi moves from place to place, following his reindeer, he leaves sets of wives and tents along the route. The Chukchiis trade between tribes by bartering fish and pelts.

The Chukchiis are hospitable and offer strangers board and shelter. In their houses (yarangas) the woman of the house strips you for the men and women go practically naked inside.

She kindly feeds you tea and walrus meat which has been cut in chunks and preserved in a pit where it first decays a while and then freezes. It is eaten without being first thawed. The people are filthy and their huts are filled with lice.

"The women wipe the tea mug 'clean" with their dirty skirts and pour out tea for the guests. When everyone has drunk his fill, any dregs are poured back into the pot for the next time."*

Their primitive customs include measuring time by the movement of the sun and counting by fives. They show their religion by piling walrus tusks in a heap. In this way they believe they ask the walrus god to bring more walrus to the region.

The Karakee natives at Cape Navarin use the wapak, which is a mushroom, for the alcoholic effects it gives them. These natives use snow houses as permanent winter quarters.

"Save at Cape Navarin, the natives do not build snow houses as they do along the North Atlantic coast."[146]

It is the custom for all the native tribes of northern Siberia to go into partial hibernation during the coldest weather. They sleep for hours and days, huddled around a stove and move only to eat and stoke the fire.

The mortality of the natives of Siberia's tundra is lower than the birthrate. Many of the inhabitants are using wooden

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* THE VOYAGE OF THE CHELYUSKIN BY MEMBERS OF THE EXPEDITION translated by Alec Brown, p. 251, MacMillan Co. N.Y.1935.

146. NORTHWEST OF THE WORLD by Olaf Swenson.

huts in place of mud houses and reindeer tents. There is no longer cheating among the tribes. Schools, dispensaries, dental clinics, and bathhouses are accepted as part of their lives. Promising young men are sent to the Institute of the Peoples of the North where they take courses and return as leaders of their tribes.

Russia has developed her portion of the Arctic so that her airways and flying conditions are better known, and her towns have greater populations. At Norilsk, on the Yenisei River, there are minerals held as a military secret. Norilsk had an estimated population of from ten to thirty thousand in 1944. Igarka, also on the Yenisei River, had a population of twenty thousand in 1939 and had grown rapidly, in a five year period, by use of airplanes that brought the necessary supplies.

Minerals

Rivers of the Soviet Union are being developed and used for hydro-electric power. There has been prospecting and drilling for oil along the rivers that flow north.

The Kola Peninsula seems to be rich in minerals. It ranks third in world output of nickel. Apatite, which is used in making a high grade fertilizer, is found north of the Arctic Circle in the Khibin Mountains of the Kola Peninsula. It is considered an industrial wonder of the world. Magnetite iron is mined in two places west of Kola Bay. One is near Murmansk. Aluminum is worked from the inferior nepheline deposits on the peninsula. The natural resources of this tundra area are rare earths and pearls.

Coal and oil are taken for power from the Pechora River basin near the Arctic Circle.

Lead and zinc are taken from Vaigach Island, a related structure of the Ural Mountains. Gold and nickel are found in the Urals. Potassium salts are found in the estimated quantities of fifteen billion tons on the western slopes of the Northern Ural Mountains. Mining in the Urals is handicapped by the extremely cold winters and distance.

Nickel and gold have been found in the Yenisei region. Coal reserves are located inland from the Dudinka near the mouth of the Yenisei River and has a possible future development.

> "The coal is as good as the best that comes from Cardiff, it is said. They have been known for many years, but no regular working has yet been started. Five hundred tons of coal were mined in 1905 and carried with reindeer over the tundra to Dudink."*

A small petroleum output is handled in the Nordvik region of Yakutsk.

Gold is found in many places throughout the Chukchi Peninsula. The best deposits are found along the upper Kolyma River in the northeastern part of the Soviet Union.

South America

Topography

The south and southwestern part of South America is included in the tundra. Tierra del Fuego is a group of large and small islands, the largest of which is Isle Grande. The tundra

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* THROUGH SIBERIA THE LAND OF THE FUTURE by Fridtjof Nansen, translated by Arthur G. Chater, p. 156, Frederick A. Stokes Co., N.Y. 1914.

coastal areas are very rugged. The country facing the south is consistently rugged and mountainous. Small islets are around Cape Horn.

Tierra del Fuego (land of fire) was named by Magellan because of the lighted fires he saw on it from afar. The islands have interior snow-capped mountains and glaciers. Beagel Channel has scenic glaciers. The islands of Tierra del Fuego are 360 miles from east to west and 160 miles from north to south in the widest part. Tierra del Fuego belongs, about equally, to Chile and Argentina. The mountainous character of the country makes it inconvenient for travel. Its northern peninsula is the continuation of the Patagonia Plateau. The highest peaks in the Darwin Range are Mt. Darwin, with an elevation of 7,061 feet, and Sarmiento, with an altitude of 7,550 feet.

Climate

Koppen classifies the southwestern tips of Chile and Tierra del Fuego as tundra area.[147] The temperature of the latter, at approximately 55 degrees S latitude, has a cold month average above 32 degrees Fahrenheit and a warm month average below 50 degrees Fahrenheit. The Polar Pacific air mass brings unstable weather in the form of rain and snow. This air mass crosses the Andes south of 30 degrees S latitude. The Polar Atlantic air mass moves toward the equator on the eastern side of Tierra del Fuego.

147. THE CLIMATE OF THE CONTINENTS by Kendrew.

The climate is very unpleasant because of the freezing temperatures and the south and west winds which bring snow. Evangelist's Island, at the west end of the Strait of Megellan, has a warm month temperature of 46.8 degrees Fahrenheit and a cold month temperature of 39 degrees Fahrenheit. Snow and sleet are common in winter. At Puntas Arenas, where there is more protection, the mean temperature for the warmest month is 52½ degrees Fahrenheit. The winter mean temperature is near freezing. In the warm month period. Puntas Arenas records 19.4 inches of rain.

Precipitation is high and amounts to about two hundred inches annually. In western Tierra del Fuego, permanent snow lies below twenty-five hundred feet.

> "In Tierra del Fuego the zone of permanent snow is 2,300 feet above sea level. The tops of many of the mountains only are covered with ice caps; at several places glaciers still discharge icebergs into the coastal fiords."*

In summer the weather is fine and the water smooth. Even in this season, the climate depends upon the wind. In the summer, the thermometer shows a temperature in the thirties because of a south wind. A north wind brings a temperature as fair as that of England. Cape Horn is foggy.

"The weather, which may change quickly and without warning from bright, calm summer sunshine to a blinding snow storm; the seas smooth one minute, may be churning the next."**

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* LATIN AMERICA by Preston James, p. 255, Lothrop, Lee, & Shepard Co., N.Y. 1942.
** Ibid, p. 79.

East winds rise light and increase with a snow or rain squall. The heaviest and most lasting gale blows from the south and often lasts thirty-five to forty hours. Summer winds are high but the gales are shorter in duration. North winds bring rain. In the northeastern part of Tierra del Fuego, the climate is more agreeable.

There are so few hours of sunshine that living conditions are unfavorable. Summers have wonderful long twilights. Winter daylight begins at 9 A.M. and ends at 2:30 P.M. - a day of only 5½ hours.

Vegetation

On the rugged, mountainous country facing south, there is no agriculture. At Cape Horn, nothing but a little grass grows on the islands. Tundra growth in the form of grass and brush is found adjoining and intermingled with the tree growth at the base of the mountains. On Tierra del Fuego, tree growth reaches the farthest poleward at 56 degrees S latitude. An evergreen beech, of the Antarctic deciduous variety, is found here. Winter's bark tree, and holly-leaved shrubs of barberry, fuschias, and veronicas are a part of the plant life. Ascending the hills, scrub growth replaces trees and, above that, are lichens. The northern peninsula of Tierra del Fuego has shrub growth. The Andes contain undifferentiated mountain vegetation. Native berries and fungi serve as food for the Fuegians.

Animals

Dogs and otters are the animals of Tierra del Fuego. The

Fuegian dog resembles a fox and is the size of a terrier. In the sea are dolphins, penguins, seals, and, occasionally, small birds.

Inhabitants

The Fuegians have a stationary character due to the inclement weather and the nature of their country. The islands contain a large population especially on the shores of the Straits of Magellan. On the Shilean part of the archipelago, at Porvenir, Isla Grande, there are about five thousand inhabitants. The people are short of stature; their legs are small and ill-shaped because they sit on their calves.

During the coldest weather, the Fuegians wear practically no clothing and sleep, curled up like animals, on the wet ground. The males wear a guanaco skin flung over their shoulders and reaching a little more than half-way down their backs. Some men do not even wear this garment. Women are usually dressed a little more decently with a larger skin. Even the youngest female has the same covering which displays a modesty in these uncultured peoples.

The women do all the work such as paddling canoes, gathering shell fish, rearing the children, and building wigwams. The Fuegians subsist mainly on shell fish. In the morning, when the water is low, they collect this food. During the winter and summer, the women dive to collect sea eggs. They fish from a canoe. There is a scarcity of fish and mollusks.

"The Fuegians' food lies on the shores of different islands, and their journeys are all performed in the

canoe; so that being cramped in sitting, their legs are ill formed, and the females, who are keepers of the canoe, from that circumstance, are worse shaped in the lower expremities than the men."*

The Fuegians have never mixed with the population in the rest of the country. The island ranches are primitive with crude houses and no contact with the outside world.

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* VOYAGE TOWARDS THE SOUTH POLE by James Weddell, p. 191, 1827.

PART III

SUB-POLAR TAIGA

Broadview

Topography

The taiga, or sub-polar areas of the world, are large plains of Tectonic origin located in North America, northern Europe, and as far east as Verkhoyansk in the Soviet Union. Effects of glaciation in Canada's interior lowland and the northwestern area of the Soviet Union are the most extensive on the earth's surface. Gradational features of glaciation and rivers are present as moraines, till, and sedimentary rock.

Drainage of the taiga is deficient because permanently frozen sub-soil makes under drainage impossible. As a result there is bog soil with a high peat content and numerous lakes and swamps in the recently glaciated areas. Spring floods are caused by the northern rivers melting first at their sources. Inundation cannot be helped for these rivers flow poleward and remain frozen longer at their mouths.

The most common soil in the taiga is an impoverished, ash-colored podzol. The gray color tells that this soil lacks important soil fauna, has a low humus content, and is leached

excessively. The under layer is compact and impervious. It retards proper drainage and hinders the rooting of various kinds of plants. The dry podzol is structureless and powdery. The wet podzol clods when plowed. A layer of few leaves adds a raw acid humus. Therefore, if huge amounts of lime and fertilizer could be added, the podzol soil might be moderately productive. As it is, the podzols are considered the most infertile of the earth's soils. Glacial scouring removed much of the soil covering and left exposed rocks. This rock mantle is broken, by mechanical frost action, into coarse fragments and rock promontories. In summer the exposed rock is subject to chemical weathering because of the excessive moisture and acid humus.

Climate

The sub-polar climate is in the higher middle latitude of 50 to 65 degrees N. On the poleward boundary a 50 degree isotherm is established for the warmest summer temperature. The temperature range for the sub-polar areas is usually from -50 degrees Fahrenheit to 50 degrees Fahrenheit. Three months usually exceed the 50 degrees Fahrenheit limitation and the temperature of the warmest month averages 66 degrees Fahrenheit. In winter the average mean temperature drops to -46 degrees Fahrenheit. The cold pole of North America is located 100 miles south of the Arctic Circle and in the Soviet Union the cold pole is 200 miles farther south. Due to these variable summer and winter temperatures freezing and thawing takes

place to great depths sometimes reaching as deep as two hundred feet.

The fifty to seventy-five days growing season has short periods without danger of frost. The border between the sub-polar and the humid continental climates has a growing season of about one hundred days.

On the continents of North America and Asia the forest is most northerly in a district remote from any pronounced influence of a warm ocean current.

The weather cycle is fairly regular with seasonal anticyclones and cyclones. The short spring season, in interior sub-polar Soviet Union and North America, is comparatively cloudless. In summer the polar front moves northward. The short summer has long days. In June at 55 degrees N latitude there are 17.3 hours of sunshine; at 60 degrees N latitude, 18.8 hours of sunshine; and at 65 degrees N latitude, 22.1 hours of sunshine. The sun makes the long summer day vary from warm to hot. A twilight continues even when the sun is 18 degrees below the horizon. The shift of the wind to the north brings a chill and mid-summer frosts which are significant. This feature has retarded permanent settlement of the taiga. A short autumn precedes the coming of winter. Frost occurs in August and ice in September. The winter, with its long nights, has its blizzards and cold waves. The polar continental air masses originate in sub-polar anticyclones over the snow covered Northern Hemisphere continents. These anticyclones

prevail in winter and cause a more stable air mass with less specific humidity. Anticyclones repel storms. The air current from a snow surface increases the stability of the air mass. In winter the continental climate temperature hovers near the average of 0 degrees Fahrenheit. The maximum sunlight on December 21 at 60 degrees N latitude is 5.7 hours, at 65 degrees N latitude it is 3.3 hours. The futher north one goes, the shorter the hours of sunlight. During the sub-polar dark period such activities as sledging, hunting, grazing, and fishing are carried on with the aid of the light of the celestial bodies. At this time print can be read without eye strain. Explorers prefer to travel in the Arctic winter because of the frozen surface. The Canadian National Railroad from The Pas to Churchill was built on frozen ground and is the cheapest railroad built in Canada on the mile for mile basis.

Taiga precipitation is low ranging from ten to twenty inches a year. Scanty precipitation is caused by low temperature, low humidity, strong continental winter anticyclone with its settling air and diverging winds, and the great size of the land masses. Winter precipitation falls, for the most part, in the form of snow. In the forest the snow is two to three feet deep. The heaviest snowfall occurs at the southern margin of continental anticyclones which hold back the cyclones. It is common for the dry hard snow to last five to seven months. Frosts prevent the melting and evaporation of

two to three feet of snow in the taiga areas. Winter days are often overcast with low stratus clouds and ground fog. Long winter nights are slightly cloudy. The annual distribution of precipitation is concentrated in the summer months. Rainfall is both convectional and cyclonic due to the northerly movement of the cyclones, the higher temperature, and the higher specific humidity. High latitude air is clear with a blue-violet sky in which sounds can be heard long distances.

The air of the taiga must acquire a mean temperature of 39½ degrees Fahrenheit before the ice in rivers, lakes, and swamps will break up completely. When the frozen land thaws the stench is often overpowering because of its decaying vegetation and animal matter.

Vegetation, Animals, and Inhabitants

The native vegetation consists of extensive xerophytic soft-wood forests. These immense and monotonous forests are predominantly coniferous. About seventy-five per cent is spruce, fir, larch, and pine, while the other twenty-five per cent is deciduous birch, poplar, willow, and alder. The taiga, with its short growing season, has unfavorable conditions for tree growth. The trees are small and stand so close that little sunlight can make its way through. Where the sun does shine through there is bush vegetation. In the darker places bog vegetation is abundant with much sphagnum moss, other mosses, and lichens of many varieties. The forest has a low economic value because of its inaccessibility and the presence of lakes and swamps. Commertial agriculture of any sort is

likely to be unsuccessful under the present conditions. The scarcity of vegetation and animals keeps the population sparse. Fur bearing animals with valuable pelts support the scanty population. Hunting and fishing are the chief pursuits. Trapping and hunting are done during the winter months. The population of northerly peoples is estimated to be about 500,000 or less than one per square mile. Violent deaths are common among these hyperboreans.

Communication and transportation affords a difficult problem among the members of a sub-polar region.

North American Taiga

Topography

Poor soil and numerous lakes and swamps are the characteristics of North America's taiga. Rugged topography allows a small scale agriculture. Highways and railways have been discouraged by the rough topography of lakes, streams, and abrupt cliffs. Summer travel is done by canoe and winter travel is by dog team. Harbors, open in the summer, may be closed in the winter.

The central region of Alaska has a low relief with broad lowlands covering an area of 200,000 square miles.

The Yukon and Kuskokwim Basins lie between the Alaska Range on the south and the Brooks Range on the north, and extends from the source of the Yukon River in Canada to the Bering Sea. These two basins have rolling flat-topped hills which are drained by the two river systems that have normal

erosion. The Kuskokwim River is the shorter of the two. On the Yukon River there are narrow river terraces from Whitehorse to Circle. Marshy flats occur near the great bend and the lower course is virtually at sea level. The delta is shallow with a width of sixty miles. Vessels are unable to enter the delta. Due to the frozen sub-soil of this area, normal absorption is impossible.

The soil of the Yukon and Tanana River valleys is the most productive in Alaska. Loams and silt loams fall in various groupings. The sandy, grayish-brown soils of the Tanana River bottom are six to ten inches deep. Fairbanks soils, found on well-drained slopes, are wind laid material and brown silt loams, schists, and metamorphic rocks.

Waterways of Alaska provide a means for transportation. The Yukon River is navigable to Whitehorse, a distance of 2,200 miles. The Tanana River is navigable to Fairbanks, the geographical center of Alaska. The Kuskokwim River is navigable for 650 miles.

Because of the character of the land in the central region of Alaska, railroads and highways have been constructed. The White Pass and Yukon Railway connects Seward with Fairbanks. Richardson Highway joins Valdez to Fairbanks, and the Steese Highway crosses the territory from Fairbanks to Circle and penetrates the gold mining areas. The Alkan Highway, from Edmonton, Canada, to Fairbanks, Alaska is the most recent route developed. The Peace River Bridge along the Alkan Highway was

completed and opened in 1943 at a cost of one million dollars. Airways are the cheapest means of transportation and, so far seem to be the best solution to this problem.

Alaska is handicapped by its dimension of territory expressed in its continental magnitude and its isolation.

Two-thirds of Canada is covered by the Laurentian Shield which stretches northward in a U shaped peneplain from east Labrador, and north from the St. Lawerence Basin and the Great Lakes covering an area of two million square miles. This glaciated peneplain is composed of ancient crystalline rock, rounded hills devoid of soil, fast flowing rivers, and innumberable lakes, swamps, and muskegs (an indication of poor drainage). The ice scoured Laurentian Shield is shown by glacial deposits between rocks, old lake sediment that has filled the depressions, and swamps that are filled with decaying material. The soils of the Laurentian Shield are sandy and poor. Better soils lie in the Clay Belt.

Natural falls furnish an abundance of cheap power for manufacturing. Excellent water power sites are situated in the Ontario and Quebec Provinces of the Laurentian Shield. Because of the distance from centers of population and the fact that streams freeze in winter these sites make utilization of water power difficult. Nevertheless, the streams have stimulated manufacturing and mining.

Glacial features extend over northern Canada's interior lowland south of Hudson Bay to the upper lakes sub-region which includes northeast Minnesota, northern Wisconsin and

Michigan, and that part of Ontario lying north of Lakes Huron and Superior. The glaciated surface of this region reveals rock gouges and depressions, many small rivers, moraine, till, and sedimentary rock. Gray podzol soils of light texture and great acidity prevail. Some areas have granitic boulders, deep sand, peat, or muck. Such soils are unsatisfactory for crops.

The general appearance of Newfoundland and Labrador is one of a low rolling terrain. The glacier left many lakes, soil bare rocks, swamps, and a fiorded coast line. In central Labrador are many lakes, ponds, swamps, and bogs. The hills in this section are irregular and unconnected. At Sangirt Lake the plateau is 550 feet above sea level with a characteristic levelness. The plateau to the west of Fraser River has an average elevation of 1,700 feet. The rivers have rapids and broad currents. Grand Falls, in the Hamilton River, lend their scenic beauty by their cascades. They are very spectacular for they are twice as high as Niagara Falls, and, within five miles, the river falls 760 feet and in nine miles it falls 900 feet. The Atlantic Ocean receives the drainage of this large river. These rivers may be a means to a possible livelihood in Labrador. Cattle could be raised or other agricultural work could be pursued for this lake region offers a protection against the chill of the Labrador Current. There is an abundance of water power which is almost totally undeveloped. An almost negligible amount is used for small

saw mills, for lighting, and for small machine shops. In this section a variety of occupations could furnish seasonal rotational activities.

Newfoundland and Labrador, situated at the mouth of the St. Lawerence River, lie in a strategic position for trade between America and northwestern Europe. They have an advantageous situation in their nearness to important fishing grounds. Newfoundland, as the western terminus of trans-Atlantic cables, wireless stations, steamer lanes, and naval and air bases, has the more strategic position of the two.

Climate

The sub-polar climate in North America extends from Alaska to Labrador and Newfoundland. Summer days are long and become longer with each degree of latitude northward. Winters are dry and long. North American sub-polar winters are not quite as severe as those of Siberia. Cold waves are often accompanied by a blizzard similar to the Buran of Siberia. Rainfall in the northern forest belt is more than fifteen inches annually. Most of this precipitation falls during the short harvest period of autumn. Autumns are usually rainier than springs. The short growing season of the taiga makes for slow tree growth and is a handicap to other vegetation.

For two months of the year the Aleutian Islands have a mean temperature above 50 degrees Fahrenheit. Due to an insufficient growing season of 130-190 days, plus lack of summer warmth and summer sunshine there is a sparcity of vegetation.

Climate causes an improper soil that has a low soil temperature. Excessive winds blow hard and often.

The Yukon-Kuskokwim Basins have a continental climate. The summers are short and hot with the highest temperature reaching 100 degrees Fahrenheit at Fort Yukon and Fairbanks. The Yukon River has warmer temperatures in summer than Hudson Bay. The winters are long and cold with the temperatures dropping to -76 degrees Fahrenheit, but the periods of extreme cold seldom last long. Fairbanks, Alaska has a cold, dry winter climate. The growing season is 80-90 days long. During the summer there are eighteen to nineteen hours of sunlight. The precipitation is from ten to twenty inches in this central region and twenty-five per cent of that falls as light snow. The Yukon River freezes in September and opens in May.

The coldest temperatures in Canada lie between Alaska and Hudson Bay. Dawson, in the latitude of the midnight sun, has warms, short summers and a winter minimum temperature of -68 degrees Fahrenheit. A July reading of 29 degrees Fahrenheit has been made, but the usual temperature is 95 degrees Fahrenheit. At Dawson, there are no summer frosts. Fort Vermilion, located at 58 degrees 27 minutes N latitude has a recorded winter temperature of -76 degrees Fahrenheit. The summer temperature of 98 degrees Fahrenheit has been recorded as well as a July temperature of 20 degrees Fahrenheit. The interior plateau of British Columbia (altitude of 2,000 to 5,000 feet) has severe cold in winter. The annual mean temperature is 14 degrees Fahrenheit with a minima at -55 degrees Fahrenheit.

July frosts are occasional. Calgary, in interior Canada, has a January mean of -12 degrees Fahrenheit. Due to these cold temperatures the regions of Canada are frozen to great depths. The Klondike gold mine is permanently frozen to a depth of 220 feet.

Spring is comparatively cloudless in the sub-polar regions of North America. During this season the water of the Mackenzie River rises to a height of forty feet above its autumnal level. This flood water sweeps over the banks and islands, cutting down trees, and demolishing the ice which obstructs the flow of water to its mouth. In the Mackenzie River valley the short frost-free periods are from fifty to seventy-five days. When the winds shift to the north, mid-summer frosts and chill occur. This feature retards permanent settlement. Winter sets in after a short autumn. Frosts occur in August and, by September, there is ice. In October small craft navigation is difficult on Canada's lakes.

Canada has between 15 and 20 inches of precipitation annually. Most of the moisture falls during the warm months. Dawson has a total annual rainfall of 12.49 inches. More favorable cyclonic conditions bring about the precipitation. Thunder storms in the Mackenzie River valley number five to ten a year. Winter precipitation falls mostly as snow. The continental anticyclones loop well south in North America.

Chinook winds are valuable on the eastern side of the Rocky Mountains and to the lower Mackenzie River because they melt the snow and make grazing possible.

The Laurentian Shield has a continental climate with long, cold winters and short, warm or hot summers. The provice of Manitoba is the coldest, in that latitude, on the continent. Winnipeg, in interior Canada, has a January mean temperature of -4 degrees Fahrenheit. Hudson Bay and the Great Lakes influence the temperature of the eastern Canadian provinces. The weather over Hudson Bay is more stormy and damp with frequent fog. In summer the ice condition gives a mean temperature 10 degrees lower than the Prairie Provinces. Moose Factory has a July mean the same as Fort Good Hope on the Mackenzie River. Hudson Bay is open during the months of July, August, and September. Drift ice is present the year around. The direction and force of the wind drives the ice. August and September are the only two months when Hudson Strait is navigable. In winter the mean temperature over Hudson Bay is about 10 degrees warmer than in the Province of Manitoba thus making the east side warmer. The January mean in the southern part of James Bay is -5 degrees Fahrenheit. In the St. Lawrence River valley, five months have a mean temperature below 32 degrees Fahrenheit. River ice halts all shipping in Montreal from mid-December until mid-April. The January mean for Ottawa is 12 degrees Fahrenheit.

The climate of the Laurentian Shield is unfavorable for agriculture because of the long winter, the short growing season, and the excessive rainfall of 24 to 34 inches which falls during the harvest period. Eastern Canada usually has

more snow than any other region except the mountains. From Winnipeg to the east coast there are four or more feet of snow. There are often seventeen feet of snow on the east shores of the Great Lakes. Along the Gulf of the St. Lawerence River are eight feet of snow. This deep snow is a characteristic of this section because cyclonic weather is typical of the poleward margins of continental climates.

The climate of Labrador and Newfoundland is disagreeable and gloomy and cloudy during both summer and winter or about six-tenths of the time. These Atlantic Provinces have over 50 inches of rain annually. In Labrador the summer temperatures are cool because of the many marshes, lakes, and drift ice. Interior Labrador has a steady climate. It might be said that they have two seasons - winter and summer, with a sudden transition from one to the other. The summer might have frost. The mean temperature of Labrador and Newfoundland is from 10 to 20 degrees warmer than on the prairie. Both have a humid atmosphere with strong winds of gale velocity. In Newfoundland the warmest month, August, has a mean temperature between 50 and 60 degrees Fahrenheit. 70 degrees Fahrenheit is not reached in most years. At St. John's, Newfoundland, there are 41 foggy days annually. Winter temperatures are higher due to the low freezing point of salt water. Summers are cool due to the floe ice and icebergs carried by the Labrador Current. Newfoundland has no point more than seventy miles from the ocean. Precipitation is heavy and falls as snow or

moisture which freezes to cause ice storms.

The continental climate of the upper lakes sub-region has severe variations from -50 degrees Fahrenheit to 105 degrees Fahrenheit. It has a longer growing season of 90 to 100 days. A precipitation of 25 to 35 inches falls annually. Ten to twenty per cent of that is snow. The long winters are favorable for making prime furs.

Duluth was built to withstand the cold of its long, cold winter. To prevent freezing slow running water is sent through the supply line pipes laid seven feet below the surface. A steam heated sweat house is provided for thawing the frozen ore. Lake Michigan's shores are frozen from December until March. Lake Ontario is colder on its northern side because of the cold winds which sweep down from Canada. The warmest location is the lake peninsula of Ontario. In Toronto the mean January temperature is 21 degrees Fahrenheit with only three months having a mean temperature below 32 degrees Fahrenheit.

Vegetation

The coniferous forest of North America extends from interior Alaska on the west to interior Labrador on the east. The forest limit bends south of Hudson and Ungava Bays avoiding the coastal areas to the north. At present, and in the future, the utilization of this forest seems unimportant. The trees are small because of the cold, short winters and the light precipitation. Most of the timber is used for local consumption. The future use of the forest will be to supply and

store water, to protect fur bearing animals, to shelter the Amerind population, and to attract vacationists.

In North America the taiga bog vegetation is referred to as muskeg. This type vegetation consists principally of sphagnum moss along with several other varieties of mosses and lichens.

The climate hinders tree growth on the Aleutian Islands because of excessive wind, short growing season, and low soil temperature. Irregardless of climatic features trees were planted on the islands in 1945.[148] Formerly the large type native plants were willows which grew to heights of eight feet at Dutch Harvor and six feet at Attu.

The Great Northern Forest of central Alaska is small and shriveled. White spruce, white birch, cottonwood, and balsam poplar grow slowly attaining diameters of about six inches. These forests have local value because of the lumber and pulp, and fur bearing animals.

Shrubs, grasses, and mosses cover the surface of the Yukon-Kuskokwim region. A light forest growth on the valley floors and lower slopes is the natural vegetation of the two basins. The grass and moss cover have been removed for the purpose of agriculture. Food crops in Alaska are limited by latitude. Potatoes have been grown as far as sixty miles north of the Arctic Circle. Other vegetables grown in Alaska are cabbages, cauliflowers, peas, turnips, radishes, lettuce,

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148. THE GEOGRAPHICAL REVIEW, 1945, July.

carrots, parsnips, parsley, beets, onions, squash, and rhubarb. Fairbanks, Alaska abounds with muskeg. The greatest obstacle to the expansion of agriculture at Fairbanks is the competition of the gold mines. There is no appreciable market for their products. Grain and root crops are the most satisfactory agricultural products grown in the Tanana Valley situated 100 miles south of the Arctic Circle, near Fairbanks.

The Alkan Highway is constructed through forests of pine, aspen, and two kinds of spruces.

The natural vegetation of the Laurentian Shield is the coniferous forest with an admixture of deciduous trees. The trees grow smaller from south to north with a northern limit determined by climate and poor drainage. Due to the cold and poor soil it requires one hundred years for tree growth to yield saw lumber. Aerial photography has aided men to tell the heights of trees and the volume of standing timber. Pine and spruce have commercial value for Canada's pulp and paper industry. The best pine, that near the St. Lawerence River, is almost depleted. The lumber industry depends upon snow and ice for the transportation of logs. The leading hard wood is yellow birch which has had more demand recently.

A successful pulp and paper industry must be within proximity of water which reduces the cost of raw materials and market. Reforestation is practiced to keep the supply continuous. Large scale processes have a good psychological effect upon the people because of their permanence.

Interior Labrador has a coniferous forest containing black spruce and balsam with white birch, larch, poplar, alder, willow, and tramble distributed throughout. The spruce forest is the most valuable natural resource for future lumbering development. Wind and exposure to sun are important factors in the distribution of forests. Snow acts as a carpet beneath the trees. The further inland from the sea, the taller and more luxuriant grow the trees. The range and variety of trees depend on the latitude, height above sea level, distance from the ocean, soil, and protection from the winds. The density of the forest makes it difficult to penetrate but it serves as the breeding ground for animals and insects. The forest of eastern Labrador is of poor quality. Some of the forests are drying up which may be due to a change in climate and the meagerness of the soil. Hard pan prevents the roots from attaining a satisfactory depth. The formation of humus is slow and the soil contains a poisonous humic acid. Stumps, roots, and trunks, found in bogs, prove that forests were greater during the post-glacial warm period. Throughout the forest the moss cover is thick making innumerable bogs and fens. There are some flowering plants and a little underbrush.

In Labrador, forest fires have devastated large areas. Usually the second growth is better than the first. Fires burn every summer. The blame for them is placed on Indian signals and lightning. Birds and beasts shun this dreary land. Caribou have been driven north and northwest.

The coniferous variety of vegetation in Labrador and Newfoundland could be developed for logging and lumbering industries. These forests are inferior to those of the Pacific coast, the lake states, and New England. They are better suited for pulp and paper enterprise. Titles for land grants are vested in the Crown (England) which controls the paper mills and railroads. A law prohibits the exportation of unmanufactured pulpwood therefore, several mills are in operation. Grand Falls, in Labrador, has the potential power necessary for the development of a greater pulp and paper industry.

The small scale agriculture of Labrador and Newfoundland is due to the short growing season, soil acidity, and rugged terrain. Subsistance farming is done. There is a serious need for fresh vegetables to combat beri-beri. In 1936 the government encouraged the clearing of land and crop planning.

In the northern part of the upper lakes sub-region the natural vegetation consists of conifers. To the south there are deciduous trees interspersed with conifers. The once dense, white pine area has been abandoned because of inconsiderate lumbermen and forest fires. It is estimated that it will take 500 years to restore it to the original white pine forest. The land is unfit for other agricultural pursuits.

Eighty-five percent of Canada is unsuited for farming. The clearing of forests didn't make favorable agricultural conditions. The Clay Belt is the most profitable area for agriculture. Peace River Valley, in Alberta, is an extensive farming area.

The Clay Belt wedge is handicapped by isolation. The future may make available 29,000,000 acres for agriculture even though unfavorable climatic conditions would hamper such pursuits. Today the average farm has 15 to 20 acres upon which are raised hardy and subsistence crops.

Animals

Native animals of the taiga are plentiful.

There are many animals native to the Yukon-Kuskokwim basins. Caribou that are valuable for their meat and skins migrate in herds - north in summer and to the Alaska Range in winter. Moose and black bear are plentiful. The wolf is the enemy of the caribou and reindeer. Thirty acres of land are required to support one reindeer. Smaller animals are the marten, mink, marmot, ground squirrel, Arctic hare, and snow-shoe rabbit. Ducks and geese nest there in summer. Gnats, black flies, and mosquitoes swarm about. Men protect themselves by wearing head nets and canvas gloves. A smudge is sometimes necessary so that animals and men can have relief. On the coast of the Yukon-Kuskokwim region the Eskimos catch walrus, seal, and whale. Trapping is the important native trade with white men. Fur bearing animals, such as the fox, are not numerous so the natives have been taught how to raise them in pens and in this way increase the fur trade. A government regulation protects the fur bearing animals from extinction. The cold weather makes their pelts particularly thick and therefore valuable.

The dog teams of Nome, Alaska, are being replaced by

airplanes. Fisheries have been established along the coasts and rivers of Alaska. Rabbits and porcupines are numerous along the Alkan Highway.

The Laurentian Shield seems to be the natural habitat of the beaver which is the most common animal in this section. Beaver furs are taken in the winter. Two-thirds of Canada's peltries are raised on this area. Traps are used to avoid damage to the pelts. Beaver, otter, and muskrat live along streams which are natural highways for canoes. The Hudson Bay Company, formed in 1670, is still in use. To keep wild life from destruction, national parks, game sanctuaries, beaver and mink farms, closed seasons, preventive patrols, and licenses for hunting and trapping, have been made effective. Other animal life in this area includes martens, minks, caribou, moose, deer, wolf, fox, bear, and rabbits. Fish is plentiful. Mosquitoes, flies, and insects abound.

The beaver is also plentiful in Labrador. This animal secures his food from the alder, aspen, willow, and birch. The grass eating muskrat stays near the beaver. Streams are the natural habitat of the mink, weasel, and otter who live on fish. The marten that lives in the deep spruce forest eats mice, birds, and eggs. Red squirrels are everywhere. The varying hare of the forested region is plentiful every seven years. Foxes, porcupines, and lynx dwell in the forest, also. Foxes live on hare and mice.

Fish are abundant in the rivers and lakes of interior Labrador. Large amounts of salmon are caught each year. Lake

trout and other small fish are easily available in the inland lakes and rivers. Fresh fish are gaining in importance. Toads and frogs are said to be found as far north on the coast as Cape Webuck.

Fishing is the economic mainstay of Labrador. The season begins in June and lasts only during the summer. Families use huge trap nets and accumulate about 39,000 pounds during the season. About 30,000 pounds are marketed in distant places so there the introduction of quick freezing is suggested. The humid climate has discouraged the drying of fish. Cod and herring are the two most plentiful fish. Others of importance are the shark, halibut, sea trout, salmon, and other small fish. Plankton abounds where the warm and cold ocean waters intermingle in the Labrador Current. These large amounts of plankton are borne forward to the continental shelf by the Labrador Current and serve as food for cod and herring. Fishing in the waters off Newfoundland and Labrador declined from 1888 until recently. Because of fishing interests in the remote coastal districts, wireless systems have been developed to furnish information.

The native animals of the upper lakes sub-region consists of the fur bearing beaver, marten, fisher, and otter. Abundant numbers of these animals are available for trapping. Deer, moose, bear, wolf, fox, fish, and fowl are the game. Fishing begins on the rivers and lakes in May. White fish and trout are caught in Lakes Superior, Michigan, and Huron. Sixty per cent of the fresh water fish are caught here. The largest

catch is taken during the summer.

Inhabitants

The people of the northern continental forest area of North America are sem-nomadic. Some Eskimos advance inland to hunt for caribou, fox, hare, and birds. This is not done extensively because land animals are not important for an Eskimo's diet or clothing.

The population of Alaska for 1939 was 72,524 or twelve persons per square mile. The Eskimo population of Alaska has greatly decreased. In the interior of Alaska the Yukon and Kuskokwim basins offer recreation in the mountains, lakes, and rivers. Little use is made of these facilities because of the small population, isolation, vast distance, insects, and the great expense for individual needs. The Yukon Valley has been largely denuded. Mt. McKinley National Park acts as a magnet to draw tourists. Wildlife is an attraction for the hunter. Alaska is valuable to the fur trader and for the tourist. Fairbanks, Wiseman, and Fort Yukon are the tows and villages of importance in interior Alaska. Fairbanks, Alaska is inhabited by the Tinneh Indians who are cousins of the Athabaskan tribe. In 1940, Fairbanks had a population of 3,304 and Circle had a population of 98. Fort Yukon, with its Indian population, owes its existence to furs. It is the oldest English speaking community in Alaska. Wiseman is located in the empty wilderness with a population of .0085 persons per square mile.[149] Many

149. REGIONAL GEOGRAPHY OF ANGLO-AMERICA, White and Fcscue.

white men went to the interior of Alaska during the gold rush. These men were above average mentally and physically. The white population is widely scattered throughout the Yukon-Kuskokwim region but is concentrated mostly along the rivers. Because there are fewer white women, there has been inter-breeding of whites and natives. The Eskimo's way of life has changed from one of dependency upon this region to one of dependency on white man's trade. Therefore, there is little chance that he can endure. The Tinneh Indians gain their live-lihood from hunting and fishing. They inhabit isolated villages along the upper courses of the rivers.

After crossing the Alaskan boundary and entering the Yukon of Canada, we find Dawson and Whitehorse are centers of most importance to the white man. In 1940,[150] Dawson had a popula-tion of 819 and in 1941, Whitehorse had a population of 541.

Agricultural settlements are found in the Clay Belt. Edmonton offers a future site for international aviation. In 1941, the population of Edmonton was 93,817.[151]

Before white man came, the Laurentian Shield was occupied by the Amerind, an American Indian or Eskimo. These 500,000 war like Amerinds subsisted by hunting and fishing. Between 2 to 5 people occupied each 100 square miles. They were divided into three groups: the Algonkins in the east and south, the Athabascans in the northwest, and the Crees in the south or west or Clay Belt. The Crees never encroached on another's

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150. & 151. ENCYCLOPEDIA BRITTANICA, 1945 edition.

territory until the coming of the white man. The Amerinds had a low culture with a thorough knowledge of the habits of wild life. Today, tracts of land are reserved where only Amerinds may hunt and trap for the Crown has the title to all other land.

Two motives led the white people to settle on the Laurentian Shield. They wanted to become fur traders by plundering the natural resources or they wished to build homes and start agricultural pursuits. The white population grew until 1855. The present white population combines many nationalities. There are French Canadians, English, Germans, Finns, Hungarians, Poles, Italians, Russians, Slovaks, and Swedes who are more recent comers. Mining started the influx of all these peoples. Economic development, for the people, comes from the forests and industries.

White man, with good intentions, taught the Amerind the use of European guns. It was thought that the Amerind's livelihood would be easier. The Amerind could not repair his gun so it lost its value to him. Reliance upon the gun made him less strong in character and impaired his health.

White man has caused the mode of transportation to change. Early inhabitants of the Laurentian Shield used canoes and dog teams. Railroads began to penetrate into the mining districts. Today airplanes are revolutionizing transportation and developing trade in products needed by industrial nations. Skiis and nose warmers are used in winter and pontoons are used in the

summer.

In Quebec Province, the aluminum center, Arvida, in 1940, had a population of 4,564 and the base metal center, Noranda, had a population of 4,000. In 1940, Port Colbourne, (in the Sudbury District) noted for its nickel, had a population of 6,503, and Flin Flon, with its refineries, had a population of 5,000.

The few Indians of interior Labrador are of Algonkian stock. They are strong yet thin. Often they go hungry for days because their wandering never allows them to stay in one place long enough to secure provisions. In the open season, they travel in canoes and in the winter, they travel on ice, in sledges or tabanasks. The Labrador Indian traps fur animals and hunts caribou which is his best food. Indian women do the fishing. At the trading posts they obtain white man's food. Food provisions for future use is never thought of in a practical way. These Indians use tepees, vapor baths, cloth tents, and sheet iron stoves. White man is edging in on the Indian's trapping grounds. These Indians are the most isolated inhabitants of North America. They are in the process of retrogression.

Labrador has a floating white population consisting mostly of men who fish for cod by the trawl and trap method and cure their catch by salting it. White people live as far north as Hebron, Labrador, the northernmost village on the Atlantic coast. The Eskimo inhabitants of Hebron depend upon the sea for their living. Most of the white population trap for Arctic

furs which are considered among the finest in the world. The trapping paths are handed down from father to son. There are no illiterates among the trappers for the father teaches his son to read, write, and draw. White men also hunt for seal and fish for salmon, herring, and cod. The white fishermen are considered sem-nomadic because they have two residences. Norwegians carry on a whaling industry and run the one factory in Labrador.[152] This industry is diminishing and will probably lose its place. The Hudson Bay Company has many trading posts in Canada. The Liveyeres now living in Labrador were originally from Newfoundland. In 1935, the total population of Labrador was 4,716 with a density of 0.4 persons per square mile.

England used Labrador and Newfoundland for its fisheries. Newfoundland has again become a Crown colony since it lost dominion status in 1935.[153] The people of Newfoundland are of English, Scotch, and Irish extraction and owe their existence to trade. They export fish, lumber, pulp, paper, and iron ore. The total population of Newfoundland is approximately 284,800 with a density of 6.7 persons per square mile.

The population of the upper lakes sub-region is small due to a poor timber business, undeveloped manufacturing, and the distance from markets. Memising, Michigan, noted for its pulp and paper, had a population of 4,409 in 1940. Duluth has grown

152. SOCIETAS GEOGRAPHICA FENNIAE, Acta Geographica, Vol. 8, 1944, V. Tanner.
153. STATESMAN'S YEARBOOK, 1946.

because it is inseparably linked with the mining industry. Fort William and Port Arthur have an increased population because of their wheat storage facilities. Recreation has been developed to attract tourists, hunters, fishers, and winter sport enthusiasts.

Minerals

The taiga of North America contains a wealth of mineral resources. At Fairbanks, Alaska, gold occurs at great depths and eight huge dredges are in operation.[154] The Nome district of the Seward Peninsula in Alaska is a working Arctic gold region. The placer method is used to mine, from the sand, the gold that originates in the quartzite veins 1,950 to 2,300 feet above sea level. The interior taiga region was burned in search of more gold. There is also coal and oil in this vicinity.

Gold, in the Klondike region of Canada, was mined by individuals who were willing to suffer hardship and adventure. The gold is mined by the placer and vein method. The stretches along the Yukon River are essentially those of gravel mining done by pan rocker or cradle, sluice boxes, and bulldozers. In some parts of the Klondike region the gold lay in the frozen ground. Water from 60 to 120 degrees is used to thaw out the frozen ground in which the gold is buried. Today placer mining is also done by huge dredges. Prospecting for gold is done by airplane. Engineers estimate the quantity and compute the probable profit. Dawson, Canada, is the metropolis for Klondike

154. REGIONAL GEOGRAPHY OF ANGLO-AMERICA, White and Foscue.

gold for it is situated at the confluence of the Yukon and Klondike Rivers. Besides gold in the Klondike region, coal is widespread. Silver, copper, lead, and platinum are mined in minor quantities, and there is clay, gravel, limestone, and marble for building stones. Whitehorse is the center of copper mining.

The Athabasca oil sands in northern Alberta hold the greatest known reservoir of oil in the world. This source covers an area of 10,000 square miles.

The Laurentian Shield is world famous for its mineral wealth. Prospecting is easy because of the barreness of the rock, accessibility by canoe routes, existence of geological surveys made along streams, and the airplane.

Gold is peppered throughout the Laurentian Shield from the Great Lakes to Hudson Bay. Canada ranks fourth in gold output for the world. As yet prospectors have just scratched the surface for this important mineral.

Cobalt, Ontario Province, is the silver center. Advantages for mining silver at Cobalt are its nearness to the surface and the veins of ore that are from one to twenty inches thick.

Copper and nickel rate as the leading industries in the Dominion of Canada. Copper Cliffs has the greatest copper refinery in the British Empire. Much copper is marketed abroad. Nickel is important in that it gives hardness to steel and, when combined with copper, it resists corrosion. The Sudbury District of Ontario, Canada, produces the largest amount of these two ores. It has an area of about 550 square miles.

There is twice as much copper as nickel. Nickel is refined at Port Colbourne. Flin Flon has a smelter and refinery. Platinum, the by-product of nickel, furnishes half the world's supply.

Arvida, Quebec, has the largest aluminum industry in the world. It supplies one half of the aluminum of North America. For the province of Quebec, Noranda, leads in producing the base metals of copper, gold, silver, silenium, and tellurium.[155]

Manufacturing is aided by the abundance of cheap water power which has replaced wood.

In the Labrador peninsula high grade hematite is found in three places. One is between Attikamagen and Petitsikapau Lakes, another is around Ruth Lake in the northwestern part of the lake plateau, and the third is around Sawyer Lake north from Birch Lake. The latter source contains sixty-four per cent iron and is estimated to contain billions of tons. Other minerals are lead, zinc, and fluouspar.

An Englishman discovered a high grade hematite ore on Belle Island, Newfoundland. This ore is mined and is a source for future supply. Lead, zinc, and fluorspar are also found in this section.

The richest quantity of minerals in North America is located in the upper lakes sub-region. Iron ores of the Mesabi Range are situated south and west of Lake Superior. This range is shallow and supplies three-fifths of the total production

155. REGIONAL GEOGRAPHY OF ANGLO-AMERICA, White and Foscue.

of the area. Other ranges of importance for iron supply are the Gogebic Range with ores below the surface, the early used Marquette Range, the Menominee Range, the Cuyuna Range, and the Vermilian Range. Copper, on the Keweenaw Peninsula, is the oldest and richest for it is chemically pure. The area is from two to four miles wide, one hundred miles long, and about one mile deep. The copper reserves are not well known. Metallurgical limestone is located on the west shore of Lake Huron. Alpena County, Michigan, furnishes the leading source of limestone in North America.

Soviet Union Taiga

Topography

The taiga of the Soviet Union has a uniform relief. Most of the taiga lies north of 60 degrees N latitude. In Siberia, the taiga is 4,600 miles from east to west and from 600 to 1,300 miles from north to south. Its area is 3,900,000 square miles.

The ground is more or less permanently frozen to considerable depths. During the warmer months, the ground thaws a little. Poor drainage makes a swampy condition. These factors hinder the construction of roads and railroads.

Podzol soils of the taiga are ash-colored and sandy with a low fertility. The coniferous trees add an organic surface to the ground that does not readily decompose and so causes acidity. Below this organic covering is a layer of sandy, ash-colored soil. The next layer is an enriched zone of dark brownish clay. The characteristic of podzol soil is the unaltered parent

material. Podzol formation is retarded in the north by marshes and in the south by deficient rainfall. One-third of the cultivated soil of the Soviet Union is podzol.

The Fenno-Scandian Shield lies in the northern third of far western Soviet Union. This area has been glaciated and the ancient crystalline and metamorphic rocks which underlay the taiga have been exposed. Soil was removed by ice scour. In general, the region is a vast, hilly plain having U-shaped valleys, coastal fiords, and innumerable lakes. Its elevation is about 600 feet above sea level. Marine sediments have been deposited by recent wave and stream action along the coasts and in the valleys and have left beach deposits and alluvial material. The surface features of Finland are the same as those of the lake region. They are altitude, lakes, and moraine. Glaciation filled many of the old lake beds. Lakes Ladoga and Onega are located here.

Bed rock is present to considerable depths under the wet marshy surface of the Soviet Union west of the Ural Mountains. The soils of this virgin forest area are podzolized types of clay and light loams. Podzol soils cover a southern area from Lake Onega to the upper Kama and Pechora Rivers including the Dvina River basin. This light-colored soil is covered by debris, from fallen trees, etc., in a region of relatively low temperature and high rainfall. Thousands of square miles are swampy and flooded. Working conditions and railroad building are restricted under these conditions.

The White Sea has three of its four arms in the taiga. To the northwest is Kandalaksha Bay, to the south is Onega Bay with its islands, and to the southeast is the Dvina Gulf. The White Sea is no more than five hundred feet deep. This sea serves as a commercial region for the Soviet Union even though it is ice-locked three or four months of the year. Ice breakers operate from one to two months in the fall and try to hurry the break up in the spring. Since rivers thaw upstream first, they pour mud, sand, and ice into their deltas before they have thawed.

In the Central Russian lowlands, lies the Dvina River plain. This river aids the Arctic drainage, lies entirely in the forest belt, and is navigable for six months. Archangelsk, an exporting port for lumber, wheat, and rye, is situated twenty-five miles up the Dvina River on the boundary of the forest and tundra. The harbor at Archangelsk must be dredged to twenty-one feet each year. The Dvina River has over three hundred docks for boats. Archangelsk serves more than one hundred vessels at a time. One channel is kept open for navigation between the one hundred fifty islands. Archangelsk, Russia's first sea port, is noted, today, for its foreign trade, its shipbuilding, and its naval base.

The Onega River system is not so important because of Archangelsk's location and monopoly of commerce at present.

Transportation in the lake region in Korelia Province is possible by water and railroad. The lakes have ample water

storage for canals which make travel possible from the Volga River through Lakes Onega and Ladoga to the Baltic Sea, and through the North Dvina River to the White Sea. The Baltic Sea is joined, by canal, to the White Sea at Soroka. An outlet to the White Sea is also provided by an overland road from Ust-Tsylma to Mezen. Sledging is done on the rivers when they are frozen. Snow also makes winter travel easier. The lakes supply canal water and an ample supply for hydro-electric power.

The Central and Southern Ural Mountains are east of the central Russian lowland. The central, hilly section has an elevation of about one thousand feet. The Southern Ural Mountains rise to an elevation of 5,376 feet. Streams flowing down the mountains deposit wastes on the plains 200 to 300 miles westward. All land forms of the Siberian taiga have normal river erosion.

The Ob River, east of the Ural Mountains, is on the West Siberian Plain. The Ob taiga was the first section of the river to be developed. The gradient of the Ob is slight because of the flatness of the plain. The Ob River is 3,200 miles long. At Tobolsk, it is free from ice one hundred seventy-five days. In summer, this region is inaccessible because of the swarms of mosquitoes and the innumerable swamps. The Vasyugan Swamp, in the Ob taiga, has an area of one hundred thousand square miles.

Most of the Yenisei River lies on the Central Siberian Upland. The Yenisei taiga extends from the south of the Angara River, 750 miles northward to Igarka. The ground is permanently

frozen. Throughout this region the Yenisei River is a mile wide and fifty feet deep. The Angara River is a tributary of the Yenisei and is remarkably clear.

The Lena River taiga lies on the Aldan Shield and the rugged Stanovoi mountains between the headwaters of the Lena River and the Trans-Siberian Railroad. The Lena River, at Yakusk, is fifteen miles wide and full of islands. It shifts frequently and floods easily. The new Baikal-Amur railway, constructed north of Lake Baikal, was done in secrecy.

East of the Lena River are the Yana and Oimekon Lowlands referred to as the Northeastern Mountain complex because they lie between the Verkhoyansk and Cherski Ranges.

To the south of the Central Siberian Upland is the old Asian Shield which includes the mountians around Lake Baikal. These mountains are broad, have no sharp peaks, and no sign of glaciation. Taiga growth is found on the eastern side of Lake Baikal. Rivers cascade into the lake and there are many mosquito-infested swamps. The Buriat-Mongol country, which is partly Siberian taiga, has an area of one hundred twenty-eight square miles. Lake Baikal has an area of 13,197 square miles, and a depth of 4,992 feet. It is the deepest fresh water lake in the world. A subsidence in the earth's crust caused its formation. Slight earthquakes and disturbances are frequent.

The far eastern coast of the Amur region and the island of Sakhalin are included in the taiga areas.

Coastal areas of the Kamchatka Peninsula belong in the

taiga. Petropavlovsk, on Kamchatka, is the most important Soviet harbor on the Pacific Ocean. It is one of the world's finest harbors. Nineteen active volcanoes are present on the Kamchatka Peninsula. Mt. Kliuchevskaya has an elevation of 15,950 feet.

Climate

The sub-polar climate of the Soviet Union affects the area from the boundary of Finland to the Siberian coast. Taiga regions are frozen to great depths. Therefore, as the northern rivers melt first at their sources, they cause great inundation.

In Soviet Europe and Central Siberia, there are from 90 to 120 frost-free days. The mean July temperature for the virgin forest is 64 degrees Fahrenheit, and the mean January temperature, from north to south, varies from 8 degrees Fahrenheit to 0 degrees Fahrenheit.

The rainfall of the coniferous forest is not great because the low temperatures cause less evaporation and humidity from the rivers and lakes. Summer rain and sunshine stimulate the growth of the trees even though daylight hours are short. Snowfall is not heavy. Winds blow what snow there is into drifts. Blizzards block communication and hinder construction. Winter snow prevents deep freezing. Eastward, precipitation is reduced and so is the tree growth.

Uniformity of relief gives a uniform climate to the Kola-Korelia and the Dvina-Pechora taigas. This maritime area has over twenty inches of precipitation. Snow remains on the ground from 100 to 200 days.

Siberian weather is not without variety. Seasons are intensified due to the drastic fluctuation of the yearly temperatures. Winters are severe and the summers are cool. The cold air masses of sub-polar continental type prevail in the vicinity of Lake Baikal. The outblowing winds of the polar continental air spread over most of Asia. Short autumns precede the winter. Frost occurs in August and, by September, there is ice. Siberian winters are colder than those of North America because of the larger land area and eastern mountains which hold the cold air. Even though the winters are severe, they are not so hard to bear because the winds are slight, skies are clear, and the humidity is low.

Precipitation, throughout Siberia, varies from ten to fourteen inches annually. In winter, the precipitation falls as snow. East Central Siberia has very dry winters and, in eastern Siberia, the snowfall is so scant that sledging is difficult. The scant snowfall falls heaviest in the Siberian taiga. From November to April, snow accumulates to a depth of three feet. The snow remains on the ground from 160 to 260 days so that the ground surface remains warmer. No permanent snowfields exist in Siberia. Slowly melting snow is ideal for tree growth.

The best growing season for the large forest area comes when there is moderate precipitation falling as rain and snow, a cool temperature which prevents evaporation, and the melting of ice and snow during the spring.

The Kola-Korilian taiga has a severe climate with a short

growing period. There are less than one hundred frost-free days. Considerable precipitation falls in this area due to the marine influences. Rain falls late in the summer and snow falls from October until May. The annual precipitation for the southern portion is 24 inches as compared to 16 inches in the north.

The White Sea is frozen from November to April. At Archangelsk, the annual average temperature is 31 degrees Fahrenheit with an annual precipitation of 15 inches.

In the Dvina-Pechora taiga, the climate is rigorous. Winds at Ust-Tsylma, on the Pechora River, are violent and treacherous. Rivers in this region are frozen from 180 to 200 days a year and are subject to serious spring floods. In summer, the rivers are used to float logs. Spring, in the interior of the sub-polar Dvina-Pechora taiga, is comparatively cloudless.

In the Central Urals, the average temperature is below freezing for 170 days.

The Ob taiga has a typical boreal climate with long, severe winters. The annual precipitation varies from 14 to 18 inches with considerable snow. Winter ice in the Ob River, near Tobolsk, is 30 to 40 inches thick. At Tobolsk, the river is ice-free about 175 days. The river floods in the spring.

The Yenisei taiga has permanently frozen ground. Spring floods are caused by water that cannot penetrate the frozen subsoil. In summer the top soil thaws to a depth of two or three

feet. The lowest temperatures of the Yenisei valley have been recorded near the Mongolian border. Because the Yenisei River is a mile wide and fifty feet deep, it acts as a climate unifier in that region.

The climate of the Lena taiga is the driest and coldest of any in Siberia. Precipitation is from 6 to 12 inches annually. Yakutsk has a total annual precipitation of 13.7 inches. At Yakutsk, the Lena River is frozen for 210 days. Spring is short for, at Yakutsk, there is 25 degrees difference between April and May. Summer temperatures there run high. The July average temperature is 66 degrees Fahrenheit with a common daily maximum of 80 degrees Fahrenheit. An occasional maximum of 90 degrees Fahrenheit is reached. For three months, the temperature is greater than 50 degrees Fahrenheit. In Yakutsk, the January mean temperature is -46 degrees Fahrenheit with seven months below freezing and five months below zero.

The coldest inhabited places on earth are the Yana lowland and the Oimyakon Plateau. Verkhoyansk and Oimyakon are known as the ice box of the world for their average January temperature is -59 degrees Fahrenheit. Verkhoyansk is the cold pole on the land surface of the earth. It is located in the northeastern part of Siberia on the Arctic Circle. Low minimum temperatures of -83 degrees to -95 degrees Fahrenheit have been recorded. The highest January mean at Verkhoyansk was -13 degrees Fahrenheit. From Verkhoyansk, the temperature increases in all directions. The center of the high pressure area is

south of Verkhoyansk so that this area is practically cloudless. Characteristic of taiga climate is the short autumn season. This is most evident at Verkhoyansk when the temperature falls 40 degrees from October to November. There, too, the range of temperature is greater. Rapid changes occur from month to month and cause a temperature range over 100 degrees.

Lake Baikal begins to freeze in November and remains frozen for four and a half months. The ice attains a thickness of nine feet. Such an ice condition affects the winter cold and the summer coolness. The area around the lake has perpetually frozen soil. Its mean annual temperature is about 30 degrees Fahrenheit. Winter temperatures range from -40 degrees to -18 degrees Fahrenheit. The summer temperatures are from 59 degrees to 68 degrees Fahrenheit.

Nikolaevsk, at the mouth of the Amur River, is ice-blocked 220 days of the year.

Vegetation

The natural vegetation of the Soviet Union taiga is the coniferous forest. The forest extends from the Finnish boundary and the White Sea and spreads farther south toward the interior then narrows out as it moves eastward to the Pacific Ocean. This large reserve forest has been exploited recently by the Soviets.

Ninety-six per cent of the land area of the Kola-Korelian Peninsula is covered by taiga forest. In the Dvina, Mezen, Pechora taiga there are three hundred sixty square miles of

virgin forest extending from the tundra to Leningrad and Moscow and the upper Volga River, and from the White Sea and Lake region eastward to the Ural Mountains, then south to Magnitogorsk. 67 degrees N latitude determines the limit of tree growth in the Kanin Peninsula, 68½ degrees N determines the tree limit along the Pechora River. Pine, spruce, fir, and larch are the predominant trees in this boreal forest, the choicest coniferous forest but the most difficult to work. In the Dvina-Pechora taiga, tree growth is slow. 150 to 170 years are required for a log to attain 18 inches diameter. Most of the cutting is done in the Lake Region which supplies lumber and timber products. Most of the logging is accomplished in the winter when snow and ice make the work easier. Products from this valuable coniferous forest are shipped from Leningrad and the White Sea. Logs are floated down the Dvina River in rafts. They are sawed in mills run by electric power. Lumber and tar from pines go to foreign markets.

After the logs of the forest have been removed, good pastures are left. In the forest clearings, grain crops of oats, barley, and rye are grown along with leaf and root crops for local use. The bramble, whortle, raspberry, currant, and golden berry are among the many varieties of fruit made into jam.

On the lower slopes of the Northern Ural Mountains grow conifers that decrease in number toward the summit. 68 degrees N latitude serves as the tree limit in the mountain area.

Lumbering operations are scarce at the base of the Ural Mountains.

Siberia has a wealth of timber in her estimated 1,083,000 acres of forest that extend from the Ural Mountains to the Pacific Ocean. Seventy-one per cent of this enormous belongs to the government. This boreal forest of conifers is a virgin woodland. The northern part has pine, fir, larch, Siberian cedar, wild cherry, willow, poplar, and birch. The southern part contains deciduous trees such as the elm, aspen, poplar, and Tartar maples.

Five types of taiga are found in Siberia. The Ob taiga is referred to as the Western Siberia Swamp-forest. It covers an area in the middle and lower Ob River basin. The more severe climate is responsible for the change in species of trees. On this marshy area, the Siberian fir far outnumbers the deciduous trees mixed in the impenetrable undergrowth. Larch is rare, birch and aspen are scattered, willow, alder, and poplar grow in thickets along the streams, and whortle and bilberry are common.

The second type of taiga is the West Siberian Larch-Fir forest that extends from the upper Ob River basin through the greater part of the Yenisei River basin and on to the Altai Mountains. Siberian larch is adapted to growth above frozen ground. The Yenisei taiga is a tractless expanse of conifers and whitewoods. This cool, temperate forest has stone pine, Siberian fir and larch, silver fir, spruce, and cedar. Not much

undergrowth is present because the area is dry but some peat bogs and marshes do occur. The northern taiga has no commercial value.

In the southern part, there is splendid commercial pine which is less common in the north where it grows to less than one foot in diameter. The open forests on the Altai Mountains have taller trees. Logs are floated down the Yenisei to the Arctic coast. Here they are taken by caravans of ships and airplanes, through the Kara Sea, to Europe. Grain crops are grown near the Arctic Circle.

The third type of taiga is the East Siberian Forest which extends from the Yenisei River basin to the Stanovoi Mountains and the Lena River. Forest growth is poorer here because of the long severe winter and the dry cold winds. Because of the hills, marshes are rare and undergrowth is infrequent. The Daurian or Eastern larch grows east of Lake Baikal. Other trees are the Siberian fir, Scots pine, and spruce.

The fourth taiga region is the Amur forest with its deciduous trees.

The fifth and last taiga woodlands are the Pacific Forests on the slopes of Sakhalin and Kamchatka. Eastern larch, Siberian fir, and cedar are the important trees here.

Lumbering is the leading occupation of the virgin forest. Most of the industry is carried on in the western area where rivers act as highways for transporting the logs to mills and cities. The per annum cutting in the state forests could be two and one-fourth billion cubit feet. Because it is so

inaccessible, less than that amount is actually cut. White Sea ports send away one-sixth of the lumber, and Baltic Sea ports export one-half of it. Great Britain receives fifty per cent of the exported lumber.

Animals

The taiga of the Soviet Union has many fur bearing animals, chiefly of the rodent type. They are the rabbit, squirrel, fox, wolf, sable, ermine, lynx, and bear. Many furs have been exported from the Asiatic part of Russia. Fur bearing animals are more abundant and are taken more freely from the Northern Ural Mountain region. Ruthless hunting has caused a scarcity throughout the virgin forest area so that the fur industry is growing less important. The area could produce a large income if restricted hunting were enforced.

The raising of dairy cattle is increasing in the Dvina-Pechora taiga region. The city of Kholmogory, on the Dvina River, is noted for its choice cattle which find good grazing pasture in the forest clearings.

The organic material from the Mezen, Dvina, and Onega Rivers attracts many herring to the White Sea. Inhabitants of the Lake Region take these fish from the coast of the White Sea and Kandalaksha Bay. Women assist with the local fishing for herring and salmon. A large portion of the fish is marketed fresh. Canning centers are at Murmansk and Kandalaksha. Cod and haddock are caught in the Arctic waters.

Seal come to Lake Baikal by way of the Yenisei and Angara

Rivers. Several kinds of fish are in the waters of the lake. Among them are sturgeon and the golomyanka which is a deep water fish that swims more than two thousand feet beneath the surface. Gulls and herons nest near the lake. Cattle raising is done in the surrounding region in spite of the frozen soil.

Kamchatka Peninsula and the Pacific coast are especially important for their fisheries. Ninety per cent of the fish caught are salmon. Fisheries and canneries are in Japanese hands. Kamchatka Peninsula is the best hunting ground for brown and grizzly bears. They are plentiful. Cherry red foxes and Russian sable are also hunted.

Inhabitants

Korelians, Zyrians, and Russians inhabit the Lake Region of the Soviet Union. The Russian population is estimated at two hundred seventy thousand and the total population of the Korelian region with 469,145 - a density of 8.9 persons per square mile. In 1939, Monchegorsk had less than 25,000 inhabitants, and Kandalaksha had 7,799. These semi-nomadic peoples move frequently to fish and to trap fur animals. Fishing seems to be the chief occupation. Fishing villages flourish on the Pomorie shore of the Onega Gulf. Other people are engaged in lumbering, mining, and the dairy industry. A peasant industry makes homespun linen into flour sacks. The convent on Solovelskie Island, in the White Sea, is now used as a federal prison. Leningrad owes its standing to its culture and intellectual atmosphere. Here there is more skilled work on products.

In the Dvina-Pechora taiga, Russians inhabit the western part; Zyrians, the eastern; and Bashkirs, the southeast. Belief that this forest area is due for great future development seems justified because of the depletion of the west European forests. Towns have been built up along the streams where the people can be sure of transportation in the dense boreal forest. Snow and ice aid winter transportation whereas the wet soil and mosquitoes isolate the area in summer. Archangelsk, with an approximate population of 281,091 in 1939, is a center for shipbuilding and mills. Vologda, the key city to the coniferous forest, located on the Sukhona River, has a population of sixty thousand. This city is reached by a system of lakes, canals, and rivers. As an important railroad center, it serves Archangelsk, Moscow, and has a through east-west line. Because of the Five Year Plans, lumbering and milling has expanded. This city has a market for furs, tractors, and lace. Kotlas, situated at the junction of the Sukhoma and Vichegda Rivers at the head of the Dvina River, is an outlet for lumber. Wheat is imported to this city by overland railroad from Siberia. The city of Veliki Ustyng has a population of approximately twenty thousand and is a trading center. Travelers are served here during the time the Yug River pours sand into the master stream. In the north, located on the big turn in the Pechora River, is Ust-Tsylma with a population of two thousand. This town was established in 1542 by people interested in the fur trade. It marks the northern limit of civilization in the Dvina-Pechora

taiga. Lumbering, trapping, and fishing are the chief activities. Wheat is brought in by the system of rivers. The Zyrian town, Ust-Sysotsk, on the Vichegda River, has a population of five thousand. It is a commercial center for furs, logs, and forest products because it is located on a river route leading up to northern Siberia. Ufa had gained its importance from the east-west railroads and rivers leading to the Volga-Kama systems.

The Vogul and Finno-Ugrian tribes inhabit the base of the Northern Ural Mountains. The people are bonde and short of stature. They keep herds of reindeer and hunt in the mountains. The hides are sometimes marketed. This region is probably the most backward area in the Soviet Union taiga section. No towns exist and human habitations are rare. In the middle and southern Ural Mountains are eight cities with a population of about one hundred thousand each. Magnitogorsk had a population of 145,870 in 1939.

In 1578, Yermak began the conquest of Siberia. About two centuries ago, this area of the Soviet Union began to be developed.

Large areas in the Ob taiga are without any settlements because swamps and mosquitoes make them unfit for human existence. Tobolsk, however, had 23,500 people in 1939.

In 1926, the total population of Siberia was fifteen million. The people are descendants of the Palaeo-Siberians who, during the great movement,[156] numbered about a million. Today these

156. ASIA by L. Dudley Stamp.

peoples are given tribal names. There are the Voguls, Ugrian Ostiaks, and Samoyedes who hunt, fish, and breed reindeer. The northeast tribes are the Chukchees, Koryaks, and Kanchadals. The Koryaks inhabit a portion of Kamchatka Peninsula. These people also hunt, fish, and breed reindeer. Other northern tribes are the Yukaghirs and Yenisei Ostyaks who are allied with the Ainus of Japan and the Aleutians. Gilyaks are a Pacific coast tribe.

The three types of Siberian natives who have a Mongoloid strain are the Tunguses who occupy the taiga from the Yenisei River to the Pacific Ocean; the Lamuts who are probably the same as the Yakuts of the Lena River valley; and Buriats - Mongols of Lake Baikal.

The Tungus tribes of the Yenisei are gentle and peaceful. These people make their livelihood by hunting. Igarka, with a population of twenty-five thousand,[157] is a port city on the Yenisei. Because of its sheltered anchorage, cargoes can be transferred from river boats to ocean vessels. It is located within the Arctic Circle four hundred miles south of the Yenisei estuary. Krasnoyarsk, on the southern Yenisei River, has a wood-working industry.

The Yakuts of the Lena River valley and the cold pole are of Turkic strain and number less than a quarter million. The Yakuts (Lamuts) have very little contact with white civilization.

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157. ENCYCLOPEDIA BRITTANICA 1945.

They are energetic, ambitious, industrious, agile, graceful, and honest. They breed Siberian horses and engage in agriculture as far as their climate will allow. With their skillful fingers, they make small Russian axes. A yurta (log cabin) is their home. They are very dirty and smelly.

> "Even the sub-Arctic Yakuts are able to sleep in winter at a temperature of -58 degrees Fahrenheit near a wood fire under an open sky. They strip quite naked and, having no sleeping bags, simply cover themselves with their clothes instead of a blanket. Snow falls on the bare body and melts without causing them noticeable inconvenience."*

Yakutsk, on the Lena River, is the capital of the Yakut Autonomous Soviet Socialist Republic with a population of 10,513 in 1939. Due to the gold along the Aldan River and on the Aldan Shield, the population is now about 40,000 according to Cressy[158] and less than 25,000 according to the 1945 Encyclopedia Brittanica. Verkhoyansk has less than 25,000.

The Buriat-Mongols of Lake Baikal are related to the Manchus by a blend of the Mongols and Tunguses. These nomadic peoples are the dirtiest of the Mongoloid strain. According to their lamaism religion, which is a form of Buddhism, water defiles part of their creed. They believe in the transmigration of the soul therefore, lice or wolves are permitted to live after they have fed on bodily flesh. These people raise livestock and carry on agriculture. The capital, Ulan Ulde, has become industrialized. Its factories manufacture munitions, tanks, trains, and glass. Packing houses and an underground

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* PROBLEMS OF POLAR RESEARCH American Geographical Society, No. 7, 1928, p. 192.

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coal-gasification plant are located here. The first two Five Year Plans helped develop Ulan Ulde's industries. Russians do most of the work in the factories. In 1939, Irkutsk, situated southwest of Lake Baikal, had a population of 243,380.

The mortality in most of the tribes is lower than the birth rate. Wooden huts are replacing the mud houses and reindeer tents. Schools, dispensaries, dental clinics, and bathhouses are now an accepted part of their lives. Young men who seem to be promising are sent to the Institute of the Peoples of the North to learn to become leaders of their tribes.

Petropavlovsk, a harbor on the Pacific coast, had a population of 91,678 in 1939.

Minerals

The Soviet Union has a rich potential source of minerals and hydro-electric power is being developed on all the important river systems. The Lake Region contains valuable deposits of apatite, feldspar, nephelite, mica, iron, coal, copper, barite, rocks, and clay. The apatite reserves in the Kola Peninsula are approximately two billion tons. The mining of nephaline syenite. on the Kola-Korelian Peninsula, along with the mining of apatite, has increased the population of Kirovsk to 50,000.[159] Apatite is exported raw for it is difficult to reduce to a proper fertilizer. Feldspar and nephalite, from the head of Kandalaksha Bay, are valued for their potassium and kaolin content. Barite is mined near Lake Onega. Rocks and clay are

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exported for processing. There is enough water power for electricity near Kandalaksha.

Oil, coal, and mica feldspar come from the Dvina-Pechora taiga. Along the upper Pechora River are limited quantities of bituminous and anthracite coal. Gas and iron ores are found in the central area and along the southern margin of the virgin forest. The iron is manufactured locally.

The Ural Mountains contain a diversified and valuable mineral supply. These mountains furnish coal, oil, iron, copper, platinum, silver, gold, nickel, aluminum, manganese, asbestos, lead, zinc, magnesium, chromium, potash, talc, soapstone, and building stone. The Ural Mountains are the Soviet Union's second industrial base. Railroads cross the Central Ural Mountains with lines on either side. Gold is found in lode and placer deposits. Salt, silver, and gold have been taken from these mountains since the fifteenth century. Platinum comes from Nazhni Tagil in the Urals. One third of the world's supply comes from Russia. Gems and semi-precious stones have been taken from the Urals since the nineteenth century. Asbestos is secured near Sverdlovsk. The long fiber percentage of this asbestos is greater than that of Canada. The Soviet Union holds second place in the world output of asbestos.

In the Yenisei River region, coal and iron are the most important minerals. The Kuznetz region has rich coal deposits and forms the southern boundary of the sub-polar zone. The Yenisei brown coal at Chulyn and Kansk is undeveloped. There

are enormous reserves of coal on the Tunguska Platform. Along the Angara River are undeveloped iron reserves. Iron ores have been located at Telbes in the Kuznetzk Basin and at Minusinsk in the Yenisei Basin. In the Altai Mountain area there is copper, gold, zinc, and silver. The pottery industry at Yeniseick, on the southern Yenisei River, is an important development.

Gold deposits in the Lena River basin are the second largest in the world. One of the best deposits is found along the Aldan River, and other deposits are in the Olekma-Vitim River region. Mining is done by the placer method. The Yakut Republic contains more than 350 useful minerals and ores. Some of these are oil in the Yakutia Nardvik region, coal reserves in Sangar-Khai, and iron in Botom. Further east in Siberia, good gold deposits are found along the Kolyna River.

In the Irkutsk Basin, east of Lake Baikal, are important iron and coal deposits. The Irkutsk Basin extends for 300 miles along the Siberian Railroad and is greatly benefited by this transportation. Ulan Ude is situated near Djidensk Tungsten Combinat, one of the world's largest tungsten mines. Its manganese mine is probably the largest in Siberia. Tin is found here, also.

Other Siberian coal reserves are located along the Amur River valley, and the island of Sakhalin. Iron is found along the Amur River. Petroleum, for power, is found on the Soviet Union's portion of Sakhalin. Kamchatka has a small output of petroleum.

European Taiga

Topography

The Fenno-Scandian Shield extends across the northwestern area of the Scandinavian Peninsula. Since it is ice-scoured and has glacial drift over most of its surface, it resembles the Laurentian Shield in character. In elevation, it is 3,000 feet above sea level.

Norway, as a part of the Fenno-Scandian Shield, has patchy, thin, and infertile soil. Lofoten Islands are made up of bare rock and thin soil. In the Trondheim region, the softer rocks have been eroded to make a rolling relief. The port of Narvik, Norway, is never frozen and this serves for exportation of iron ore from Kiruna and Gellivare, Sweden. Many sportsmen and tourists are attracted by the scenery of Norway. Many lakes, bogs, peat areas, and bare rock are present throughout its forests.

In the northern section of Sweden, glacial features are shown in the lakes, waterfalls, and glacial cirques. Sweden's Norrland area extends from Lapland to 61 degrees N latitude and covers 60% of the total surface area of Sweden. The western part of the Norrland region has true mountains rising to elevations of five thousand feet. Harnosand, Sweden, in the Norrland region located on the Gulf of Bothnia, is built upon deposits of marine clay left by the glacier at an elevation of one thousand feet. Ninety per cent of the water power reserves are situated here. The Porjus power plant supplies four hundred fifty thousand horse power, furnishing the electric

power required to run the electrified railway. It travels from Boden, Sweden, to Narvik, Norway and is the electric railway farthest north. The machine room at Porjus is sunken 165 feet into the mountain as a protection against the low temperatures of winter. The Central Lake District lies south of Norrland. Much industry is carried on in this district including the manufacture of high grade steel. Most of the drainage of this area flows southward into the Gulf of Bothnia. Streams lie close together and form seventeen thousand miles of timber floating channels. Floods are uncommon because the streams melt from the south toward the north. The Swedish shore along the Baltic Sea is stony and practically tideless. Because this sea water has only eight per cent salinity, it is sometimes used for drinking.

The plateau of Finland has noticeable glacial effects. The rocks are bare and polished and there are deposits in the form of moraines and eskers. The soil is poor. One third of the area of Finland's surface is in bogs, marshes, and lakes. The great lake section is located on a plateau in central and northern Finland between 61 degrees and 62 degrees N latitude. One hundred thousand lakes dot eleven per cent of Finland and are in three systems. The Saima Lake waterway, in the east, covers more than 2,500 square miles which makes it one of the largest in Europe. The Pajane system is located in the central part and the Nasi system in the west. Waterways connect the lakes to make a more extensive route for navigation. Lakes, with dams, are reservoirs for waterpower. Imatra Rapids, on

the Oulu River, with its boiling current, has been converted into white coal to benefit industrial growth.

Finland, the most poleward nation of the world, has an old rolling surface in the upland region and rises toward a mid-eastern boundary. The higher parts have hills, moors, swamps, peat bogs, and marshes. The upland region descends toward the Arctic and becomes more hilly with waste land, and has many lakes, the largest of which is Lake Inari. The deep valleys of Pasvik and Petsamo creeks cut through high level deltas that are productive plains. The elevation of the taiga and tundra regions ranges from 500 to 4,000 feet. The average elevation of the Plateau of Finmarken is 2,000 feet.

For the most part, northern transportation in Finland is undeveloped. The Great Arctic Highway from Rovaniemi to Lunahama goes a distance of three hundred forty miles.

Climate

A marine climate saves Norway from a severe weather. Prevailing westerly winds blow from over the Atlantic Ocean and bring more moderate temperatures. At Bodo, Norway, 67 degrees N latitude, the temperature range is from 26 degrees to 56 degrees Fahrenheit. Summers have low hanging clouds and mist. In winter, the sun remains at a very low angle though clouds sometimes hide its light. The low altitude of the sun gives little effect of solar radiation and causes a great inequality of day and night. Skomvar station, on Lofoten Islands, has an average February temperatures of 31 degrees Fahrenheit making it 40 degrees warmer than the average temperature for that

latitude. No North Atlantic harbor to Cape North is frozen in winter. Some precipitation of Norway falls as hoar frost. Such a zone was found by Hans Aklmann on Lofoten Island at an elevation of two thousand feet and another is in the sub-arctic mountain region.

The mountains separating Norway from Sweden prevent the full marine influence of climate from penetrating into Sweden's taiga. The northern part of the Gulf of Bothnia has longer, darker winters and a shorter growing season although the region is very productive. Twenty-two to twenty-six inches of precipitation fall annually.

Finland has a severe continental climate with long winters throughout the entire country. In general, Finnish winters are mild. The lake region on the plateau has a January temperature of 14 degrees Fahrenheit. Inland water freezes. Aland Island, at the southern tip of Finland, has an average January temperature of 28 degrees Fahrenheit.

Vegetation

The maritime climate and long summer daylight allows growth of vegetation in Norway beyond 70 degrees N latitude. Hardy grains mature near sea level.

Twenty-four per cent of Norway is forest. The northern coniferous forest lies south of the birch forest in the eastern section of Norway. Some sizeable trees grow in the gorges upstream from the fiords but three-fourths of Norway's coniferous forests are high up on the slopes and in the interior of the

country. A need of reforestation is felt here. The vegetation shows peculiarity due to its recent migration from the south and east. Winter is the proper harvest time.

Sweden has more forests than Norway. The forests are Sweden's greatest resource and means of wealth. Her timber region extends from the Arctic Circle to the Dal River. In northern Sweden, the forest covers the whole region except the small bit of far northern tundra. Spruce and pine are the predominating conifers. Toward the west, in the higher elevations, the conifers give way to birches and aspens. In Juntland the pine dominates. Fir is plentiful, also. The forests lack other species. The boundary between the coniferous forest and the birches almost forms a contour line. Sections of the coniferous forest penetrate far up the valleys. Government forest reservations are found on continuously lower levels as the north is approached.

In Sweden's Noorland area, use of the forest began during the last third of the nineteenth century. Rivers and snowfall aid the lumbering industry. Most of the lumbering is done in winter. Cooperative unions handle the cutting, manufacturing, and marketing. At one time, there was fear of too rapid deforestation. Today, the annual growth and cut are approximately equal.

The timber of Sweden amounts to fifty per cent of its exports. She supplies fourteen per cent of the world's wood pulp and seventy per cent of this product is exported. The cities of Sundsvall and Harnosand export pulp and timber.

Matches are manufactured from the aspen trees.

Other vegetable products are rye (grown as far north as the Arctic Circle) and cranberries and blueberries, grown along the northeast shores of the Baltic Sea.

Finland's vegetation is forest and peat moss. Finland is the most densely forested country in Europe. The southern limit of the coniferous forest extends from the head of the Gulf of Bothnia to the northern end of Lake Ladoga. Pine and spruce are the dominant coniferous trees. One-half of the forested area is pine. Silver birch is the next important tree. Linden grows in the boreal forest south of 63 degrees N latitude.

The forests of northern Finland are owned by the state. Here the trees are small and of little value. Lake Inari, located north of the Arctic Circle, is surrounded by forests. Pine grows on dry soil and in peat bogs. Spruce, which originated in Russia, grows on wet soils.

Finland's resources are in her forests. She is next to Canada as the world's greatest lumber exporter. She supplies European demands. Canals have been constructed in the lake region to furnish water power for operating the mills. Pine is used for milled lumber and fir for pulp and paper. Three-fourths of Finland's forest products are exported as boards, battens, veneers, paper pulp, cardboard, matches, and paper. Paper is shipped to the United States.

Primitive farming is done along the Russian border of Finland. Meadows and forests cover the area. Rye, oats, and barley are grown for home consumption.

Animals

Fish are caught in the ocean and the lakes throughout this region. The Lofoten Islands of Norway serve as a base for fishermen who catch cod, herring, mackerel, and salmon. The fishing season lasts from February until June. Most of the fish are dried or salted and shipped to Spain and Portugal. Some fish are used for fertilizer.

Fishing is done in the lake region of Finland. Along the Russian border, the primitive farmers seldom raise animals.

Inhabitants

The inhabitants of the European taiga are the Norwegians, the Swedish, and the Finnish in their respective countries. The nomadic Laplander spends the winter in or very near the taiga region. There is a Lapp settlement at Tromso, Norway. In 1936, Tromso had a population of 10,336 and Narvik had 9,920.

The Finnish people have done much to open the Petsamo Region. This has made the people have a deep love of the sub-Arctic. Most of the inhabitants live along the lake shore. At Kuopio, the population is twenty-one or twenty-two to the square mile.

Minerals

Sweden is the only country having minerals of importance in its taiga. Her chemical industry is outstanding for producing fertilizers. Superphosphates, calcium nitrate, and calcium carbide are manufactured by electro-chemical processes. Boliden, Sweden, supplies two per cent of the world's gold.

South American Taiga

Portions of Tierra del Fuego are classified as taiga. Trees and patches of grass grow at the base of the mountain. The islands are studded with small, crooked beach trees which grow to a height of twenty-four feet and a diameter of 8 to 10 inches.

CONCLUSION

The Polar and Sub-Polar regions have a varying topography with high mountains, plateaus, and extensive lowlands. Mountains restrict exploration, the tundra is no grave obstacle, but water in the taiga handicaps activities. Ice and soil abbreviate their utilization. Climate has a stronger influence upon these regions than any other single feature. Climate maintains the glaciated condition, restricts vegetation, and makes an impoverished soil. Man will be able to live satisfactorily in these areas for they do not have any lower temperatures than some sections of the temperate regions. Certain places in the polar regions have never known an ice age. It is the constancy of the frigid temperature that discourages human adjustment.

Large scale vegetation is restricted to the tundra and taiga. Size and variety of plants and trees are minimized by climate and soil. Large and small animals are plentiful for food and furs. No man in the polar regions need starve for quantities of live game abound. Natives will live contentedly and healthfully according to their primitive ways if white man does not intervene.

Today nations and individuals are primarily interested in the wealth of mineral resources contained in these areas. This is the frontier for exploitation and development. Many men are needed to secure and utilize these vast stores.

The future route to Asia from America will cross the polar Arctic. After these new frontiers are opened, the distance from North America to Europe and Asia will decrease and the world's sphere, once so unconquerable, will be more easily accessible because the Polar and Sub-Polar regions are no longer barriers.

COMPREHENSIVE ABSTRACT

It is unquestionably true that the Polar and Sub-Polar regions will have a future usefulness and value. A thorough knowledge of much of the territory remains unknown. Large land masses, archipelagoes, islands, peninsulas, seas, bays, and inlets have been explored and mapped. Should the potentialities in these areas come into use, as they probably will, a need for intensive research by well-trained persons in each field of endeavor must be undertaken. The time has come when people everywhere should learn about the possibilities cached in our Polar and Sub-Polar regions. The world's population should understand how the development of these regions may influence their lives. Twentieth century folk will eventually substitute the truth instead of believing the films that

> "In recent years,.... have shown the northern countries of the earth as lands of intense cold, where live Eskimos and seals, strong men in furs with bears sniffing at their heals, where weaklings die, and dogs pull sledges mile after mile through blinding blizzards."*

The latitudinal location of these vast areas immediately signifies cold with ice or snow, distance, and danger. A knowledge of such facts indicates precaution to lessen any hardship which may arise. Today various scientists have proved that

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* Bertram, Colin THE TECHNIQUE OF POLAR TRAVEL, p. 8.

other factors influence the conditions present in these regions and that latitude has minor importance. Several agents determine the Polar and Sub-Polar geographical features.

The configuration of these areas includes the large continental land masses of North America, Europe, the Soviet Union, and Antarctica; several archipelagoes and many islands northward from the continents; and ice conditions. Antarctica, Greenland, and the northeastern part of the Soviet Union have the greatest elevations. Slightly elevated plateaus, rounded hills, lowlands, and swamps are the more uniform characteristics of the other areas. Glaciated zones of North America and Europe have a smooth, rounded rock surface. Although both have corresponding likenesses the Laurentian Shield of North America has a greater extent than the Fenno-Scandinavian Shield of Europe.

The ice capped areas are heavily glaciated but the tundra and taiga regions have navigable rivers. The drainage system is unusual in that the majority of rivers flow northward causing spring inundation and flood. Some areas in the tundra and taiga would be more isolated if the rivers couldn't be used. Mining, lumbering, and trapping industries depend upon the water systems for transportation and power. Most of the water power is unharnessed.

The ice condition in the seas varies. Wherever there is an open ocean current ice is almost negligible. If the ice drift is hindred by a land mass or island the denser will be the pack or floe ice. Wind frees certain ocean areas of ice and causes

a congestion in others. During the summer season much ice melts and floats away. The ice caps of polar area have hazardous crevasses, sasturgi, and haycocks. The explorer, weather forecaster, or pilot must understand the surface conditions if successful utilization of the territory is to be made.

The climate is undesirable for general human occupation. Winter and summer temperatures are low in the ice capped areas. Great temperature variations in the tundra and taiga regions make a less favorable winter and a more favorable summer. Climate has made exploring, traveling, and occupancy of these regions difficult. Scientists are experimenting with types of polar clothing, shelters, foods, and machines in an effort to understand the handicaps confronting any peoples of the world should they use the territory for permanent settlement, trans-Arctic travel, business, or warfare. Whether man can really conquer the polar regions and remain supreme over a natural climatic situation is unanswered. The future will prove the worth of such a conquest. Weather forecasting from the polar regions has value as an aid to shipping, aviation, and predicting the climate in temperate regions. This phase of investigation is in its infancy.

Vegetation is plentiful on the land and in the sea. The colder ice capped regions produce growths of the lower forms or none at all. Tundra vegetation of grasses, mosses, and lichens provide expansive pastures for the wild and herded animals. This lush vegetable life can furnish food for greater herds of

animals in the future. The taiga has vast forest reserves to be utilized. The limitless quantity of conifers will supply future lumber and pulp and paper industries. The forest provides a natural habitat for fur bearing animals and birds. Sea vegetation abounds in immeasurable quantities yet each separate plant is minute or microscopic.

Polar and Sub-Polar fauna are numerous in quantity and variety. The larger land animals graze upon the ample pasturage of the tundra. Smaller fur bearing animals secure the protection of the taiga forest. Sea animals exceed the proportions of the larger land animals. Probably the sufficiency of food is responsible for their size and number. Remarkable amounts of vegetation supply animal sustenance but there is future possibility of multiplying animals plentifully enough to provide meat for peoples of the temperate zones. Furs in the market are inadequate because the trapping conditions restrict accessible areas. A future fur industry, properly managed, may become a satisfactory resource.

The Polar and Sub-Polar regions are sparcely inhabited with various tribes who are believed to be of Mongolian ancestry. These tribes procure their livelihood from their environment. The white population has become established in the parts of the taiga and tundra which are accessible to the forest, trapping, hunting, fishing, small scale agriculture, and mining. Several towns and villages have sprung up because of these interests. In the polar regions the white man adjusts himself to the

native's method of existence. The maintenance of health is essential and people from the temperate region must adopt the native ways without hesitation. To date no better method has been found which will be convenient to present transportation and the pocketbook. White man is needed in the polar areas today to increase scientific knowledge and aid civilization. Results of their achievements may eventually induce more white settlers to locate there permanently.

Mineral resources attract industrialists and industrial nations. There are enormous supplies of ore deposits and oil reserves which, when exploited, will increase the potential precedence of the nation who claims a title to that territory.

More people are beginning to realize the true conditions and continued scientific endeavor will add knowledge and aid plans for their development of these geographic regions.

BIBLIOGRAPHY

Adams, Lt. Harry: BEYOND THE BARRIER WITH BYRD, M. A. Donohue and Co., N.Y., 1932.

Bertram, Colin: THE TECHNIQUE OF POLAR TRAVEL, W. Heffer and Sons, Ltd., Cambridge, 1939.

Blanchard, Raoul, and Crist: A GEOGRAPHY OF EUROPE, H. Holt and Co., N.Y., 1935.

Bogardus, James F.: EUROPE, Harper and Brothers, N.Y., 1934.

Brown, Alec - Translator (original by Members of the Expedition) THE VOYAGE OF THE CHELYUSKIN, Macmillan Co., N.Y., 1935.

Brown, R. N. Rudmose: THE POLAR REGIONS, E. P. Dutton and Co., N.Y., 1928.

Byrd, Richard E.: ALONE, G. P. Putnam's Sons, N.Y., 1938.

---------- DISCOVERY, G. P. Putnam's Sons, N.Y., 1935.

---------- LITTLE AMERICA, Putnam, N.Y., 1930.

Cressey, George B.: ASIA'S LANDS AND PEOPLE, McGraw Hill Book Co., Inc., N.Y., 1944.

Croft, Andrew: POLAR EXPLORATION, Adam and Charles Black, London, 1939.

Downes, P. G.: SLEEPING ISLAND, Coward McCann Inc., N.Y., 1943.

Ellsworth, Lincoln: BEYOND HORIZON'S, Doubleday Doran, Garden City, N.Y., 1938.

Finch, Vernor C. and Trewartha, Glenn T.: ELEMENTS OF GEOGRAPHY, McGraw Hill Book Co., Inc., N.Y., 1936.

---------- PHYSICAL ELEMENTS OF GEOGRAPHY, McGraw Hill Book Co., Inc., N.Y., 1942.

Greely, A. W.: POLAR REGIONS IN THE TWENTIETH CENTURY, Little Brown and Co., Boston, 1928.

Griffin, Harold: ALASKA AND THE CANADIAN NORTHWEST, W. W. Norton and Co., Inc., N.Y., 1944.

Hubbard, George: THE GEOGRAPHY OF EUROPE, D. Appleton-Century Co., Inc., N.Y., 1937.

James, Preston: LATIN AMERICA, Lothrop, Lee, and Shepard Co., N.Y., 1942.

Joerg, Wolfgang Louis Gottfried: A BRIEF HISTORY OF POLAR EXPLORATION SINCE THE INTRODUCTION OF FLYING, American Geographical Society, N.Y., 1930.

---------- PROBLEMS OF POLAR RESEARCH, American Geographical Society, N.Y., 1928.

---------- THE WORK OF THE BYRD ANTARCTIC EXPEDITION 1928-1930, American Geographical Society, N.Y., 1930.

Kendrew, W. G.: THE CLIMATES OF THE CONTINENTS, Clarendon Press, 1937 (3rd edition).

Lengyel, Emil: SIBERIA, Random House, N.Y., 1943.

Mill, Hugh Robert: THE INTERNATIONAL GEOGRAPHY, D. Appleton and Co., N.Y., 1901 (3rd edition).

Nansen, Fridtjof - Translated by Chater, Arthur G.: THROUGH SIBERIA THE LAND OF THE FUTURE, Frederick A. Stokes Co., N.Y., 1914.

Nordenskjold, Otto and Mecking, Ludwig: THE GEOGRAPHY OF THE POLAR REGIONS, American Geographical Society, N.Y., 1928.

Ommanney, F. D.: BELOW THE ROARING FORTIES (an Antarctic Journal), Longmans, Green and Co., 1938.

Richardson, Sir John: THE POLAR REGIONS, Adam and Charles Black, Edinburgh, 1861.

Smith, J. Russell: NORTH AMERICA, Harcourt, Brace and Co., N.Y., 1925.

Stamp, Lawerence Dudley: ASIA, Dutton, N.Y., 1935 (3rd edition).

Stefansson, Vilhjalmur: ARCTIC IN FACT AND FABLE, Foreign Policy Association, N.Y. (Headline Series..No. 51), 1945.

---------- ARCTIC MANUAL, Macmillan Co., 1944.

---------- GREENLAND, Doubleday Doran and Co., Inc., N.Y., 1942.

---------- THE FRIENDLY ARCTIC, Macmillan Co., N.Y., 1925.

---------- THE NORTHWARD COURSE OF EMPIRE, Harcourt, Brace and Co., N.Y., 1922.

Stefansson, Vilhjalmur: ULTIMA THULE, Macmillan Co., N.Y., 1940.

---------- UNSOLVED MYSTERIES OF THE ARCTIC, Macmillan Co., N.Y., 1939.

Swenson, Olaf: NORTHWEST OF THE WORLD, Dodd, Mead and Co., N.Y., 1944.

Tanner, V.: ACTA GEOGRAPHICA NO. 8, (Outlines of the Geography, Life, and Customs of Newfoundland - Labrador - the Eastern part of the Labrador Peninsula) Helsingfors, 1944.

Trewartha, Glenn T.: AN INTRODUCTION TO WEATHER AND CLIMATE, McGraw Hill Book Co., Inc., N.Y., 1937.

Valkenburg, and Huntington, Ellsworth: EUROPE, John Wiley and Sons, Inc., 1935.

Van Cleef, Eugene: FINLAND, THE REPUBLIC FARTHEST NORTH, Ohio State University Press, Columbus, Ohio, 1929.

Weddell, James: A VOYAGE TOWARD THE SOUTH POLE, Longman, Rees, Orme, Brown, and Green, London, 1827.

White, C. Langdon and Renner, George T.: GEOGRAPHY - AN INTRODUCTION TO HUMAN ECOLOGY, D. Appleton - Century Co., Inc., 1936.

---------- Foscue, Edwin J.: REGIONAL GEOGRAPHY OF ANGLO-AMERICA, Prentice - Hall, Inc., N.Y., 1945.

ENCYCLOPEDIA BRITTANICA.

WINSTON ENCYCLOPEDIA (consulted Bureau of Business Information,) John C. Winston Co., Philadelphia.

CUNULATIVE INDEX TO THE NATIONAL GEOGRAPHIC MAGAZINE, The National Geographic Society, Washington, D.C.

FOREIGN AFFAIRS: Council on Foreign Relations, Inc., N.Y., Armstrong, Hamilton Fish (ed).

INDEX TO THE GEOGRAPHICAL REVIEW: The American Geographical Society, N.Y.

NATIONAL GEOGRAPHIC MAGAZINE: The National Geographic Society, Washington, D.C.

Philadelphia Geographic Society, BULLETIN, 1929.

THE GEOGRAPHICAL REVIEW, The American Geographical Society,N.Y.

SATURDAY EVENING POST: Curtis Publishing Co., Philadelphia.

TRAVEL: Robert M. McBride and Co., Inc., N.Y. Gilman, Coburn (ed).

GOODE'S SCHOOL ATLAS.

MAPS OF THE NATIONAL GEOGRAPHIC SOCIETY.

MAPS FROM THE HYDROGRAPHIC OFFICE, Washington, D.C.